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VOLUME 57 **APRIL 1954** NUMBER 676

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 56 (1953) and the Supplement published with the Index to Volume 56 (1953). Reprints of the List of Journals (1953) and the Supplement (1953) can be obtained from the Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Aeronaut. Engng Rev.	*Aeronautical Engineering Review.* [Abstracted by *Index Aeronauticus.*]
Aircraft Prodn	*Aircraft Production.* [Abstracted by *Index Aeronauticus.*]
Hochfrequenztech. u. ElektAkust.	*Hochfrequenztechnik und Elektroakustik.* Akademische Verlagsgesellschaft Geest and Portig K.-G., Sternwartenstrasse 8, Leipzig, C1. [Volume 63 No. 2 (1953) continues the pagination from Volume 63, No. 1 (1944).]
J. Roy. Aeronaut. Soc.	*Journal of the Royal Aeronautical Society.* [Abstracted by *Index Aeronauticus.*]
Revue H.F.	*Revue H.F.*, 55 rue Defacqz, Brussels (XL).
Tekn. Skr. [*Stockholm*]	*Tekniska Skrifter.* Teknisk Tidskrifts Forlag, Box 841, Stockholm 1.

Notes

The Norwegian periodical *Tekniske Skrifter* will in future be referred to as *Tekn. Skr.* [*Oslo*], in view of the Swedish periodical of the same name.

Transactions and Proceedings of the Institution of the Rubber Industry. Extension of title, starting with Volume 30, 1954.

Errata

Abstr. 1329 (1954) line 7: *for* temperature *read* temperatures.

Abstr. 1929 (1954) line 2: *for* M. AGUILA *read* M. AGUILAR.

Abstr. 2499 (1954) line 5: *for* "in strong-focusing synchrotron" *read* "in a strong-focusing synchrotron."

Abstr. 2541 (1954) line 7: for $p/m\mu = 2$ read $p/m_{\mu} = 2$.

Abstr. 2551 (1954) line 14: *for* $\sec^{-1}$ *read* sec.

Corrections to Articles

Corrections have been published, as shown below, to the articles whose abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 7455 (1952): **10,** 107 (*July*, 1953).

Abstr. 677 (1953): **10,** 124 (*July*, 1953).

Abstr. 5571 (1953): **14,** 730 (*Dec.*, 1953).

Abstr. 8653 (1953): **92,** 1587 (*Dec.* 15, 1953).

Abstr. 1074 (1954): **45,** 345 (*March*, 1954).

MATHEMATICS 51

512.3 : 535.42

3009. On the circle polynomials of Zernike and related orthogonal sets. A. B. BHATIA AND E. WOLF. *Proc. Cambridge Phil. Soc.*, **50**, *Pt* 1, 40–8 (*Jan.*, 1954).

Concerned with the construction of polynomials in two variables, which form a complete orthogonal set for the interior of the unit circle and which are "invariant in form" with respect to rotations of axes about the origin of co-ordinates. It is found that though there exist an infinity of such sets there is only one set which in addition has certain simple properties strictly analogous to that of Legendre polynomials. This set is found to be identical with the set of the circle polynomials of Zernike which play an important part in the theory of phase contrast and in the Nijboer–Zernike diffraction theory of optical aberrations. The results make it possible to derive explicit expressions for the Zernike polynomials in a simple, systematic manner. The method employed may also be used to derive other orthogonal sets. One new set is investigated, and the generating functions for this set and for the Zernike polynomials are also given. A.

512.9 : 548.1

3010. The number of independent components of tensors in symmetrical systems. A. GAMBA. Letter in *Nuovo Cimento*, **10**, 1343–4 (*Sept.*, 1953).

Making use of the fact that a general three-dimensional tensor of order n transforms under rotation of the reference frame in the same way as the set of orbital wave functions of a system p^n of n equivalent particles in the p level, some of the results of atomic and nuclear spectroscopy are employed to give a closed formula for the number, valid for tensors of any order, any intrinsic symmetry and in any crystallographic group. A. D. LE CLAIRE

517.512.2 : 517.63

3011. Summation of Fourier series by means of the Laplace transformation. P. A. MANN. *Arch. elekt. Übertragung*, **7**, 390–2 (*Aug.*, 1953) *In German.*

If the series is $F(x) = \Sigma a(n) \exp(inx)$, the method is based on the evaluation of the integral of $a(t) \exp(itx)$ with respect to t over the range $(-\infty, \infty)$. Two examples are worked out. For one, $a(n) = 1/(n - i\alpha)$, and then

$$F(x) = \frac{\pi i \exp\{-\alpha(x-\pi)\}}{\sinh \alpha\pi}.$$

For the other, $a(n) = 1/(n^2 - a^2)$ and then

$$F(x) = -\frac{\pi \cos a(x-\pi)}{a \sin \pi a}.$$

L. S. GODDARD

517.512.5

3012. Comment on "The summation of series involving roots of transcendental equations and related applications." G. KUERTI. Letter in *J. appl. Phys.*, **25**, 133–4 (*Jan.*, 1954). See Abstr. 1 (1954).

517.522

3013. Comments on summation of slowly converging series. J. H. BRAUN. Letter in *J. appl. Phys.*, **25**, 132 (*Jan.*, 1954). See Abstr. 7373 (1953).

517.522

3014. Further comments on summation of slowly converging series. I. GUMOWSKI. Letter in *J. appl. Phys.*, **25**, 133 (*Jan.*, 1954). See preceding abstract.

517.632

3015. On inverting Laplace transforms of the form $h(s)/[p(s) + q(s)e^{-\tau s}]$. T. E. HULL AND W. A. WOLFE. *Canad. J. Phys.*, **32**, 72–80 (*Jan.*, 1954).

Some appeal is made to the theory of integral equations to construct a general and practical successive approximation procedure for inverting transforms of the form given in the title, where $p(s)$ and $q(s)$ are polynomials in s, the degree of $p(s)$ begin greater than the degree of $q(s)$, and $h(s)$ is any function which does not greatly complicate the transform. The approximations converge rapidly when τ is relatively small. In some cases upper and lower bounds and asymptotic expressions for the inverse are produced. Problems from the theory of counters and the theory of heat transfer are used to illustrate the method. A.

517.632 : 538.551.26

3016. The calculation of transients in dynamical systems. E. E. WARD. *Proc. Cambridge. Phil. Soc.*, **50**, *Pt* 1, 49–59 (*Jan.*, 1954).

Shows that the calculation of transients by Tricomi's method using Laguerre functions is a practical alternative to the use of partial fractions. By taking numerical examples of Laplace transforms ranging from quadratic to sixth-power polynomials it shows that the approximation offered by this method would be acceptable for many practical uses. It analyses the composition of the coefficients of the Laguerre series, thus disclosing the conditions for quick convergence; for some transforms these conditions are not attainable. A.

518.2

3017. Tables of the Racah coefficients $W(abcd; ef)$. I. Coefficients having all their variables integral. S.-Y. OBI, T. ISHIDZU, H. HORIE, S. YANAGAWA, Y. TANABE AND M. SATO. *Ann. Tokyo Astron. Obs.* (*Ser.* 2) **3**, *No.* 3, 89–142 (1953).

Contains an introduction and 29 tables, for $ef = e0$, 11, 21 . . . 71, 22, 32 . . . 72, etc, up to $ef = 77$. For applications, see Abstr. 4246 (1953).

519.2

3018. On a method of calculating a statistical sum. I. KHALATNIKOV. *Dokl. Akad. Nauk. SSSR*, **87**, *No.* 4, 539–42 (1952) *In Russian.*

A method devised by Feynman [Abstr. 9268 (1951)] is applied to the evaluation of Spur $[\exp(-H(\boldsymbol{p},\boldsymbol{r})/kT)]$ where H is the Hamiltonian of a system with impulse operator $\boldsymbol{p}$ and position $\boldsymbol{r}$, and T denotes temperature. N. L. JOHNSON

519.24

3019. The decomposition of a series of observations by the method of iterated moving averages. S. MATTILA. *Ann. Acad. Sci. Fennicae, A1, No.* 156, 15 *pp.* (1953).

The methods of the analysis of variance are applied to a time series fitted by a moving average. Expected values of sums of squares to be used in testing for elimination of trend are obtained. N. L. JOHNSON

ASTRONOMY . ASTROPHYSICS . GEODESY 52

521.12 : 531.51

3020. The limits of Newton's law. H. POINCARÉ. *Bull. astron.* [*Paris*] **17,** *No.* 2, 121–78; *No.* 3, 181–269 (1953) *In French.*

The paper is based on H. Verne's notes of lectures given by Poincaré in 1906–7, and is concerned with possible failures in the inverse square law of gravitation. Anomalies in the motions of Mercury, the Moon and Encke's comet are discussed in detail and a critical examination is made of the various attempts at explanation that were current at the beginning of the century. Modified laws of attraction considered include the propagation of gravitational action with finite velocity and Lesage's ballistic theory. Lorentz transformations are introduced and the application of relativistic mechanics ["electron dynamics"] to planetary motion is considered. R. A. NEWING

522.6 : 535.417

3021. On the theory of Michelson's stellar interferometer. I. L. BERSHTEĬN AND G. S. GORELIK. *Dokl. Akad. Nauk SSSR,* **86,** *No.* 1, 47–50 (1952) *In Russian.*

A discussion of the limitation imposed on this instrument by atmospheric and mechanical fluctuations which prevent large separations between the mirrors being used. J. M. HOUGH

522.612 : 535.33.071

3022. The Oxford solar spectroscope. H. H. PLASKETT. *Monthly Not. Roy. Astron. Soc.,* **112,** *No.* 2, 177–94 (1952).

The prismatic spectroscope, used with the Oxford solar telescope, has a clear aperture of 15·2 cm and a focal length of 8·96 m. The linear dispersion varies from 2·8 mm Å^{-1} at λ 4000 to 0·5 mm Å^{-1} at λ 6500. The horizontal apparatus function, determined from the Kr line λ 4319·6, has a half-width of 0·048 Å with a marked asymmetry to the red. The practical resolving power at this wavelength is 93 900, less than one-third of that predicted by diffraction theory. Because of the asymmetry in the apparatus function the centres of intensity of solar absorption lines are displaced to the red by amounts which vary as their equivalent widths; precautions must therefore be adopted in the measurement of Doppler displacements. The vertical apparatus function (up and down the slit) has a half-width of 0·167 mm. This tends to wash out the spectra of fine details on the solar surface, but theory and practical experience show that spectra of solar granules can be obtained. For unanalysed white light, incident on a slit with a height of 19 mm, the general scattered light in the focal plane is 1·6%. A.

522.615

3023. A new nocturnal binocular photometer. M. GARRIGUE. *Bull. Acad. Roy. Belgique Cl. Sci.,* **39,** *No.* 4, 426–34 (1953) *In French.*

Constructional details, with dimensions, are given of a modified design of the author's portable night-sky photometer suitable for use under tropical conditions [see also Abstr. 8605 (1952)]. D. R. BARBER

523.11

3024. Physical conditions in the initial stages of the expanding universe. R. A. ALPHER, J. W. FOLLIN, JR AND R. C. HERMAN. *Phys. Rev.,* **92,** 1347–61 (*Dec.* 15, 1953).

The detailed nature of the general non-static homogeneous isotropic cosmological model as derived from general relativity is discussed for early epochs in the case of a medium consisting of elementary particles and radiation which can undergo interconversion. The question of the validity of the description afforded by this model for the very early super-hot state is discussed. The present model with matter-radiation interconversion exhibits behaviour different from non-interconverting models, principally because of the successive freezing-in or annihilation of various constituent particles as the temperature in the expanding universe decreased with time. The numerical results are unique in that they involve no disposable parameters which would affect the time dependence of pressure, temperature, and density. The study of the elementary particle reactions leads to the time dependence of the proton-neutron concentration ratio, a quantity required in problems of nucleogenesis. This ratio is found to lie in the range $\sim 4{\cdot}5 : 1 - \sim 6{\cdot}0 : 1$ at the onset of nucleogenesis. These results differ from those of Hayashi mainly as a consequence of the use of a cosmological model with matter-radiation interconversion and of relativistic quantum statistics, as well as a different value of the neutron half-life. A.

523.152.2

3025. On spherically symmetrical accretion. H. BONDI. *Monthly Not. Roy. Astron. Soc.,* **112,** *No.* 2, 195–204 (1952).

The special accretion problem is investigated in which the motion is steady and spherically symmetrical, the gas being at rest at infinity. The pressure is taken to be proportional to a power of the density. It is found that the accretion rate is proportional to the square of the mass of the star and to the density of the gas at infinity, and varies inversely with the cube of the velocity of sound in the gas at infinity. The factor of proportionality is not determined by the steady-state equations, though it is confined within certain limits. Arguments are given suggesting that the case physically most likely to occur is that with the maximum rate of accretion. A.

523.154

3026. On the effect of interstellar matter on the motion of a star. K. N. DODD AND W. H. MCCREA. *Monthly Not. Roy. Astron. Soc.,* **112,** *No.* 2, 205–14 (1952).

It is shown that the retarding force upon a star exerted by interstellar matter through which it moves is effectively the same as that previously evaluated by Bondi and Hoyle, whether or not accretion takes place in the way they consider, so long as the interstellar matter has the general properties they assume. It is, however, suggested that the actual accretion may occur in the way considered without the operation of the rest of the mechanism envisaged by Bondi and

Hoyle. If there is a density-gradient transverse to the path of the star, there is a transverse force, and this is evaluated. In this case any accreted or captured material must possess angular momentum about the centre of the star, and this also is evaluated. Some of the calculations illustrate the power of the vector methods in dynamics expounded by Milne. A.

523.161

3027. The alignment of galactic dust. T. GOLD. *Monthly Not. Roy. Astron. Soc.*, **112,** *No.* 2, 215–18 (1952).

It is shown that the dynamical interaction between galactic gas and those dust particles which are elongated will, in certain circumstances, lead to a partial alignment of those particles. The direction which is preferred by the long dimension of the particles is that of the relative velocity between gas and dust. The possible relation between this effect and the observed polarization of starlight is discussed. A.

523.161 : 533.6

3028. The motion of a gas cloud expanding into a vacuum. D. C. PACK. *Monthly Not. Roy. Astron. Soc.*, **113,** *No.* 1, 43–51 (1953).

The motion of a semi-infinite gas cloud bordering upon a vacuum is studied by the method of characteristics. Problems previously discussed by Burgers and Copson [Abstr. 2314–15 (1951)] are illustrated by diagrams; they involve gas flows which are always continuous. It is shown that unless certain conditions are satisfied by the initial state in the cloud the subsequent flow cannot remain indefinitely continuous shock-waves must appear within the gas. An example of the breakdown of continuity is given. A singular solution is considered in which all the characteristics of one family are concurrent in a point of the (x, t) plane. Finally, it is shown that the high eventual velocity of these gas clouds, which was considered to be a physically unsatisfactory feature of the previous solutions, is not to be avoided by variation of the initial inhomogeneities. A.

523.162.2 : 523.852.3

3029. The red shift in the spectra of distant nebulae. H. S. SHELTON. *Observatory*, **73,** 243 (*Dec.*, 1953).

A reply to criticisms of the author's suggested explanation [Abstr. 12 (1954)]. R. A. NEWING

523.165

3030. Spatial distribution of the sources of the galactic radio-emission. I. S. SHKLOVSKIĬ. *Dokl. Akad. Nauk SSSR*, **85,** *No.* 6, 1231–4 (1952) *In Russian.*

The analysis of four papers [Piddington, Abstr. 2367 (1952); Bolton and Westfold, Abstr. 796 (1951); Allen and Gum, Abstr. 799 (1951); Hey, Fillips and Parsons, Abstr. 1205 (1946)] yields the following general characteristics of the galactic radio-emission isophots: (1) the maximum of radio-intensity is near the centre of the Galaxy; (2) three secondary maxima (two "sharp" ones in Cygnus and Vela, and a flat one near the anti-centre); and (3) a considerable intensity near the galactic poles. The division of radio-emission into two components (ionized interstellar gas, and radio-stars) shows that the secondary maxima are of interstellar origin. In the region of the Galaxy centre the gaseous component plays the main part up to $\lambda = 300$ cm. It follows that the radio-stars are not concentrated in the plane of the Galaxy, and that their intensity component in the centre is only 4·4 times that in the anti-centre; the value $d \log n/dR$ for radio-stars is $-0{\cdot}056$, i.e. ca. $\frac{1}{2}$ of that for the Cepheids. F. LACHMAN

523.165

3031. Position and identification of a bright extended radio source in Gemini. J. E. BALDWIN AND D. W. DEWHIRST. Letter in *Nature* [*London*] **173,** 164–5 (*Jan.* 23, 1954).

Interferometric observations on 3·7 m have shown the existence of an intense radio source about 50 minutes of arc in diameter, at (1950) R.A. $06^h13^m37^s \pm 4^s$, Dec. $+22°38' \pm 5'$. Observations with variable-spacing interferometers on 3·7 m and 7·9 m have yielded the general pattern of brightness distribution across the source. The source is identified with the nebulosity IC 443. The optical nature of this object is described from a photograph taken in red light with the 48-inch Palomar Schmidt. M. W. OVENDEN

523.165 : 523.852.32

3032. Radio-frequency radiation from the spiral nebula Messier 81. R. H. BROWN and C. HAZARD. Letter in *Nature* [*London*] **172,** 853 (*Nov.* 7, 1953).

A well-resolved source of radiation at 158·5 Mc/s has been observed to correspond with the position of Sb-type spiral nebula, M 81. Intensity measures for this, and other similar objects [Abstr. 2379, 3210 (1952)], have been combined with known apparent photographic magnitudes to demonstrate that a constant ratio exists between total radio, and light fluxes for late-type spiral nebulae. This result refutes the previous suggestion that the apparent photographic magnitude increases more rapidly than the apparent radio magnitude. D. R. BARBER

523.165 : 621.396.67

3033. A new instrument in radio astronomy. R. BRACEWELL. *Observatory*, **73,** 200–1 (*Oct.*, 1953).

A radio aerial system devised by B. Y. Mills is described. Two similar linear arrays, each giving a sensitivity pattern of dimensions a and b, where $a \ll b$, are arranged perpendicularly. When the aerials are switched rapidly between the in-phase and out-of-phase conditions, the variable component of the received signal comes from the small region of overlap of the two patterns, of area a^2. Since the direction of each pattern separately can be altered electrically, the system is equivalent to a large steerable aerial array, except for its lower sensitivity. With a small model of 48 dipoles in each array, one of the Magellanic Clouds has been resolved as a radio source. M. W. OVENDEN

523.5 : 538.567

3034. The strength of meteoric echoes from dense columns. L. A. MANNING. *J. atmos. terrest. Phys.*, **4,** 219–25 (*Dec.*, 1953).

Calculations of the strength of the echoes from dense meteoric ionization columns have been made in the past by assuming that the trails behave like perfectly reflecting cylinders of that radius for which the refractive index is zero. It is shown that this procedure neglects the defocusing effect of refraction

at greater radii. A general formula is obtained for the effect of refraction on echo strength. The maximum power returned from a large dense Gaussian distribution of ionization is found to be only 70% of that assumed previously. A.

523.53

3035. Radio echo observations of the major night-time meteor streams. G. S. HAWKINS AND M. ALMOND. *Monthly Not. Roy. Astron. Soc.*, **112**, *No.* 2, 219–33 (1952).

This paper describes radio echo observations of the major night-time streams for the period 1946–1951. Radiant positions and velocities have been measured for the Perseids, Geminids and Quadrantids, and orbits have been computed for each stream. The characteristics of these streams are discussed, and evidence is presented for the existence of a core of larger meteors in the region of maximum density in the streams. A progressive movement of the radiant point has been detected for the Perseid and Geminid showers, which is in agreement with previous observations. The velocity distributions indicate that there may be a spread in heliocentric velocity within the streams of the order of 1–2 km/s. Radiant positions and hourly rates are also given for the Orionids, δ Aquarids, Lyrids and the night-time Taurids and Arietids. A.

523.7 : 523.8 : 538

3036. General magnetic fields in the sun and stars. I. H. W. BABCOCK. II. T. C. COWLING. *Monthly Not. Roy. Astron. Soc.*, **113**, *No.* 3, 357–71, 371–81 (1953).

One of the series of *Reports on the progress of astronomy*. Pt I gives a brief survey of the observational work in these fields, and Pt II discusses theories of the fields. Bibliography of 85 items.

523.72 : 551.594.6

3037. The Hα radiation from solar flares in relation to sudden enhancements of atmospherics on frequencies near 27 kc/s. M. A. ELLISON. *J. atmos. terrest. Phys.*, **4**, 226–39 (*Dec.*, 1953).

The development curves of 10 solar flares observed in Hα light are compared with the sudden enhancements of atmospherics (S.E.A.s) generated by them. In confirmation of earlier work, an average time lag of 7 minutes is established between the maximum of the flare and the maximum of the resulting S.E.A. This is interpreted as an effect of "sluggishness" in the response of the *D*-layer (at a height of about 75 km) to the ionizing radiation from the flare. An analysis is made of the association of S.E.A.s with 413 flares of Classes 1, 2 and 3 during a period of 4 years. In the hours between 0900 and sunset 51% of Class 1 flares, 88% of Class 2 flares and all Class 3 flares had associated S.E.A.s. The percentage association is higher during the middle of the day and in the afternoon than in the early morning hours. It is also higher in winter than in summer. A.

523.746 : 538.566.2

Bailey's theory of sunspot noise. *See Abstr.* 3689

523.75

3038. An experimental method of assigning co-rodinates to bursts of radio-frequency radiation. V. V. VITKEVICH. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 1, 39–42 (1952) *In Russian.*

A preliminary discussion of a possible method of locating solar flares producing r.f. radiation by the use of a two aerial direction finder. The sensitivity of the method is discussed in some detail theoretically and it is shown that the method is possible.

J. M. HOUGH

523.851

3039. Self-gravitating star systems. II. G. L. CAMM. *Monthly Not. Roy. Astron. Soc.*, **112**, *No.* 2, 155–76 (1952).

The general problem of the motion of a star system in the smoothed gravitational field which the system itself produces has been considered previously [Abstr. 3290 (1951)] for the special case in which the stars are of equal mass. This restriction is now shown to be unnecessary. By a suitable definition of the velocity-distribution function the three equations which are involved in this problem can be written without any reference to the distribution of stars of different mass. The complexity of the problem is not affected by the increased generality. For a star system with complete spherical symmetry the problem is reduced to solving a single non-linear partial differential equation. A number of special solutions have been obtained, including solutions which correspond to isothermal and polytropic gravitating gas-spheres. The variation of the projected density with radius has been found for three different models, and this is compared with observations of the variation of luminosity with radius in globular clusters. The best agreement is obtained in the case of a model which has never previously been considered, but which is essentially a modification of Plummer's model in which terms involving the angular momentum have been introduced. A.

523.854

3040. An investigation of the H II regions by a radio method. P. A. G. SCHEUER AND M. RYLE. *Monthly Not. Roy. Astron. Soc.*, **113**, *No.* 1, 3–17 (1953).

Observations have been made to determine the effect of the H II regions on the radio emission from the galaxy. Since both interstellar hydrogen and early-type stars show strong galactic concentration, regions of ionized hydrogen are likely to produce the greatest effect in directions near the galactic equator. At low frequencies, where the "brightness temperature" of the general galactic radiation exceeds the kinetic temperature of the interstellar hydrogen, the absorption due to the hydrogen will exceed its emission, and a dark band is to be expected along the galactic equator. At frequencies greater than about 60 Mc/s, where the brightness temperature of the galactic radiation falls below the gas temperature, this band should appear in emission. An interferometric method of large resolving power has been used to determine the distribution of brightness near the galactic plane at frequencies of 81·5 Mc/s and 210 Mc/s. In each case a bright band about 2° wide has been observed superimposed on the general radiation. No accurate observations have yet been made at frequencies less than 60 Mc/s. A comparison of the observed brightness temperature of the band

at the two frequencies makes it possible to derive a preliminary estimate of the kinetic temperature and effective density in the H II regions. The temperature derived in this way is considerably greater than the accepted value. Observations at different galactic longitudes have suggested the distribution of the H II regions shows a marked concentration towards the centre of the galaxy. A.

523.855

3041. Frequency of separation and of interlocking of clusters of galaxies. J. NEYMAN AND E. L. SCOTT. *Proc. Nat. Acad. Sci.* [*U.S.A.*] **39,** 737–43 (*Aug.*, 1953).

Continuing previous work [Abstr. 2155 (1953)] on a statistical theory of the spatial distribution of galaxies, formulae are derived for the probability that a given cluster will be penetrated by galaxies from other clusters. The question of clusters completely imbedded within a given cluster is also examined. R. A. NEWING

523.87

3042. Remarks on the identification, in the spectra of celestial objects, of forbidden lines due to Cr III, Mn III, Co III and Ni III. J. SWENSSON. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39,** *No.* 4, 405–25 (1953) *In French.*

New tables of forbidden lines of these ions are given, with the results of a search for coincidences in the spectra of various nebulae, novae and peculiar stars, selected through the known presence of [Fe III] emission. Except for [Co III], for which the evidence is unconvincing, numerous probable identifications of previously unknown sources are suggested.

D. L. EDWARDS

523.87

3043. A spectrophotometric method for the determination of stellar radii. E. VANDEKERKHOVE. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39,** *No.* 6, 552–61 (1953) *In French.*

From gradient measures at the same wavelengths in the spectra of a pair of stars, and in a combination spectrum of these stars, it is possible to derive the ratio of the stellar radii; or, if one radius is known from an independent measurement, the radius of the second star may be found. The method is applied to the stars, Procyon and Regulus, using the known radius of Arcturus, $R = 27\ R_\odot$. Values of $R_{\text{Procyon}} = 1{\cdot}65\ R_\odot$; and $R_{\text{Regulus}} = 3{\cdot}18\ R_\odot$ are obtained.

D. R. BARBER

523.87 : 535.43

3044. Coherent and non-coherent scattering in the theory of line formation. I. W. BUSBRIDGE. *Monthly Not. Roy. Astron. Soc.*, **113,** *No.* 1, 52–66 (1953).

When the scattering of light is coherent, the exact solution of the problem of line formation in the Milne–Eddington model, with a linear Planck function $B_\nu = b_\nu^{(0)} + b_\nu^{(1)}\tau_\nu$, has been given by Chandrasekhar. This solution is found by a new method, and the method is used to solve the parallel problem when the scattering of light is completely non-coherent. This solution is exact when $b_\nu^{(0)}$ and $\kappa_\nu b_\nu^{(1)}$ are independent of the frequency ν and the depth z, κ_ν being the continuous absorption coefficient. The solution agrees with that found by Sobolev for the case $\kappa_\nu = \kappa$, $b_\nu^{(0)} = B$, $b_\nu^{(1)} = 0$. The magnitudes of the terms appearing in the solution are discussed; Sobolev's assertion that the resulting central intensities of absorption lines are much lighter than those found on the hypothesis of coherent scattering is shown to be true for lines at the limb. No definite conclusions can be drawn for other lines until the *H*-functions involved have been computed, but the same result is likely to hold. A.

523.877

3045. Contribution to the study of the convective zone of stars. C. PECKER. *Ann. Astrophys.*, **16,** *No.* 5, 321–414 (1953) *In French.*

A theoretical study of stellar atmospheres, with models comprising a surface zone in radiative equilibrium adjacent to a deeper adiabatic convective region. The model atmospheres consist in either pure H; or a mixture of H and He, ratio 85% H/15% He. The mathematical treatment is an expansion of previous researches [Abstr. 5052, 5053, 6006 (1951); and Abstr. 4576, 5284 (1953)]. In a concluding section, results are compared directly with observational data for a number of normal and abnormal stars of spectral types O to G. It is shown that the difference found between the anomalous metallic-line stars, and normal stars may be explained by a differing chemical composition; the metallic stars possessing He-impoverished atmospheres, wholly in radiative equilibrium. A useful historical survey of the subject precedes the analytical work, and 62 references are appended. D. R. BARBER

523.877

3046. Absolute stellar energy distributions, effective temperatures and the mass-luminosity relation. K. PILOWSKI. *Z. Astrophys.*, **33,** *No.* 2, 120–31 (1953) *In German.*

Previous investigations of the author [Abstr. 7903 (1952)] have been extended to include an additional 50 stars. For 21 of these, it is found that, for wavelengths > 8000 Å, the radiometric and effective Planck temperatures have equal values. D. R. BARBER

525.35

3047. Periodic fluctuations of the rotation of the earth during the years, 1947–1952. A. STOYKO AND N. STOYKO. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39,** *No.* 6, 543–51 (1953) *In French.*

A study of the seasonal changes of the earth's diurnal rotation shows that the mean amplitude of the annual term may vary (1936–1944), by as much as 20%. Results for the period, 1947–1952, exhibit a marked year-to-year fluctuation of the seasonal amplitude. For the Washington observations, it is found that the amplitude of the 14-month term is of similar order to that of the annual term.

D. R. BARBER

525.622

3048. The tides of the solid earth and their geophysical and geological significance. R. TOMASCHEK. *Nature* [*London*] **173,** 143–5 (*Jan.* 23, 1954).

The use of sensitive recording apparatus, e.g. gravimeter and horizontal pendulum, at considerable depths below the earth's surface, has enabled continuous tidal records to be observed over long periods

of time which are freed from the major extraneous surface perturbations. When analysed, these results appear incompatible with those expected for an homogeneous globe; but agree satisfactorily with results for non-homogeneous models based on the analyses of seismic waves. The major extraneous disturbing influence is that due to oceanic tides, knowledge of which is still unsatisfactory. The study of earth-tides reveals unceasing activity in the outer strata of the earth as a response to external forces, and internal stresses. D. R. BARBER

529.786

3049. Quartz clocks of the Greenwich time service. H. M. SMITH. *Monthly Not. Roy. Astron. Soc.*, **113,** *No.* 1, 67–80 (1953).

A general account is given of the development of the quartz clocks of the Greenwich Time Service, and the present installation is described. The methods by which clock performance may be studied are described and a convenient criterion is proposed. Quantitativ results are presented in tabular form. The degree o stability now attained represents a significant advanc upon that of some five years ago. Details are give of development work now in progress with a view t improving stability still further.

529.78

3050. Annual fluctuations in quartz clock error an frequency drift. H. J. M. ABRAHAM. *Natur* [*London*] **173,** 73–4 (*Jan.* 9, 1954).

Technical details are given of the performanc characteristics of one bridge-stabilized crystal, an two ring-type crystal quartz clocks operated in th S-hemisphere, 1944–50. Amplitude of annual fluctua tion of clock error was found similar to that in N hemisphere, but phase of the fluctuation was severa months ahead of that shown by N-hemisphere clock The S-hemisphere observations support previou evidence of a seasonal variation of the rate of th earth's rotation. D. R. BARBE

PHYSICS 53

53

3051. Soviet physics. J. TURKEVICH. *Nuovo Cimento*, **10,** *Suppl. No.* 4, 344–9 (1953).

A brief survey, incorporating: Historical introduction; List of principal institutes and special subjects; List of physics journals; survey of the leading physicists, mentioning the work they have been doing recently. No bibliography.

53

3052. Polish physics. W. J. SWIATECKI. *Nuovo Cimento*, **10,** *Suppl. No.* 4, 481–8 (1953).

A bibliography (73 refs) of papers published in Poland since 1947, with an outline of a few representative papers on the following subjects: Relativity; Molecular optics; Field theory; Counter physics.

FUNDAMENTALS 530.1

530.112

3053. Proposal for a new æther drift experiment. H. L. FURTH. Letter in *Nature* [*London*] **173,** 80–1 (*Jan.* 9, 1954).

Suggests that an attempt should be made to detect second-order effects using standing electromagnetic waves by observing the change in the resonance frequency of a tube resonator when the tube is rotated through 90°. R. A. NEWING

530.112

3054. "Relative" or "absolute"? Observations to determine the "absolute" motion of the earth. L. COURVOISIER. *Experientia*, **9,** *No.* 9, 317–25 (1953) *In German.*

A review of numerous investigations undertaken by the author since 1920. One series of observations was based on the detection of a small difference between the angles of incidence and reflection at a mirror moving with earth. Another series attempte to demonstrate the Lorentz contraction of the earth in its motion by observations of periodic variation in apparent latitude. It is claimed that the result indicate an absolute velocity of about 600 km/sec i direction R.A. 75°, Dec. +40°. R. A. NEWING

530.112 : 531.764.

3055. The influence of the "Lorentz contraction" o the earth on the rate of quartz clocks. L. COUR VOISIER. *Experientia*, **9,** *No.* 8, 286–7 (1953) *I German.*

It is maintained that part of the observed fluctua tions is caused by the Lorentz contraction of the earth. It is also stated that clock corrections should have opposite signs in the northern and southern hemispheres. Data from northern and southern observatories are quoted in support of the author's thesis. R. A. NEWING

530.12

3056. Compatibility of the equations of the Einstein-Schrödinger unitary theory. A. LICHNEROWICZ. *C.R. Acad. Sci.* [*Paris*] **237,** 1383–6 (*Nov.* 30, 1953) *In French.*

530.12

3057. A unified field theory with $\Gamma_\mu \neq 0$. S. N. BOSE. *J. Phys. Radium*, **14,** 641–4 (*Dec.*, 1953) *In French.*

A modified variational principle is introduced which ensures the hermitian character of the field equations but does not involve the restriction $\Gamma_\mu \equiv \frac{1}{2}(\Gamma^\lambda_{\mu\lambda} - \Gamma^\lambda_{\lambda\mu}) = 0$. Results equivalent to Einstein's follow if $|g_{\lambda\beta} - g_{\beta\lambda}| = 0$ even when $\Gamma_\mu \neq 0$. Approximate equations corresponding to negligible gravitational fields may be put in the Maxwellian form by suitable choice of certain constants occurring in the theory, but other values for these constants give equations of a different form. R. A. NEWING

530.12

3058. Relativistic particle dynamics. II. B. BAKAMJIAN AND L. H. THOMAS. *Phys. Rev.*, **92,** 1300–10 (*Dec.* 1, 1953).

For previous part, see Abstr. 3269 (1952). The relativistic dynamics for a system of non-interacting particles in Hamiltonian form is separated by a contact transformation into motion of their centre of mass and internal motion. Interaction at a distance between them is then introduced into the expression for the rest-mass in terms of the internal variables. This gives dynamics for which invariance over space displacements and rotations is trivial and which is rigorously invariant over Lorentz transformations. Earlier approximate treatments may be reduced by contact transformations to special cases of the general treatment. A.

530.12

3059. The physical basis of gravitation. R. L. KIRKWOOD. *Phys. Rev.*, **92,** 1557–62 (*Dec.* 15, 1953).

It is shown that Einstein's principle of equivalence permits the gravitational field to be interpreted as an ether flow, and the experimentally verifiable results of the relativistic gravitational theory are deduced directly from elementary physical principles by the use of this interpretation. A.

530.12

3060. The equations of motion in Einstein's new unified field theory. J. CALLAWAY. *Phys. Rev.*, **92,** 1567–70 (*Dec.* 15, 1953).

It is shown that the field equations of Einstein's latest unified field theory do not lead to the Lorentz equations of motion for charged particles in an electromagnetic field, if these particles are considered to be singularities of the field. To a fourth-order approximation, the motion of such particles is not influenced by the electromagnetic field, no matter how much charge is placed on the particles. A.

530.12

3061. Equations of motion for continuous matter of special relativity in the Lagrange variables. S. F. B. TYABJI. Letter in *Nature* [*London*] **172,** 1147–8 (*Dec.* 19, 1953).

The 4-vector equations are derived from a variational principle and are shown to be the same as the Eulerian equations when dp/ds is neglected. The two forms of the equations are also the same in the general case if allowance is made for action of pressure in creating matter. R. A. NEWING

530.12 : 530.145.6

3062. Wave and inertial properties of matter. R. SCHLEGEL. *Amer. J. Phys.*, **22,** 77–82 (*Feb.*, 1954).

The inertial properties of matter as expressed in Newton's second law, and the mass-energy equivalence, are derived as consequences of the de Broglie equation, the Lorentz transformations, and the energy-frequency relation, $E = h\nu$. Inertia is then presented as an effect resulting from the frequency, and hence energy changes with motion that result from the special relativistic time transformation and apply to mass because of the energy-mass equivalence. The de Broglie wave equation and Newton's second law are shown to be equivalent with respect to a postulate set for the deductive presentation of wave and inertial properties of matter; the de Broglie equation and Newton's second law may therefore be regarded as having the same physical content. A.

530.12 : 531.31

3063. On the origin of inertia. D. W. SCIAMA. *Monthly Not. Roy. Astron. Soc.*, **113,** *No.* 1, 34–42 (1953).

As Einstein has pointed out, general relativity does not account satisfactorily for the inertial properties of matter, so that an adequate theory of inertia is still lacking. This paper describes a theory of gravitation which ascribes inertia to an inductive effect of distant matter. In the rest-frame of any body the gravitational field of the universe as a whole cancels the gravitational field of local matter, so that in this frame the body is "free." Thus in this theory inertial effects arise from the gravitational field of a moving universe. For simplicity, gravitational effects are calculated in flat space-time by means of Maxwell-type field equations, although a complete theory of inertia requires more complicated equations. This theory differs from general relativity principally in the following respects: (i) It enables the amount of matter in the universe to be estimated from a knowledge of the gravitational constant. (ii) The principle of equivalence is a consequence of the theory, not an initial axiom. (iii) It implies that gravitation must be attractive. The present theory is intended only as a model. A more complete, but necessarily more complicated theory will be described in another paper. A.

530.145

3064. New description of field. Y. TAKANO. Letter in *Progr. theor. Phys.*, **9,** 86–7 (*Jan.*, 1953).

The classical field equations for (pseudo-) scalar, (pseudo-) vector and Maxwell fields are written down in the differential form first suggested by Cartan.

G. FIELD

530.145

3065. Field theory of equations with many masses. B. T. DARLING. *Phys. Rev.*, **92,** 1547–53 (*Dec.* 15, 1953).

This paper develops the field theory of many-mass equations with special attention to spin $\frac{1}{2}$ and the operator of the author's previous paper on the irreducible volume character of events [Abstr. 1595 (1951); 49 (1954)]. The field is assumed to interact with the electromagnetic field which is introduced in a gauge-invariant way. General expressions for the charge-current four-vector and the symmetrical energy-momentum tensor are derived and are shown to satisfy the appropriate conservation theorems. According to a theorem of Leichter, the general solution is shown to be a superposition of non-orthogonal mass states which we designate as the root fields. Nevertheless, the physical quantities, such as the current four-vector, the energy-momentum tensor, etc., are shown to decompose into a sum over those of individual mass states but with an alternation of sign for consecutive roots. The Lagrangian takes the form of an alternating sum over the individual free-field Lagrangians for the mass states, plus the usual term $+(1/c)j_\mu A_\mu$ for the interaction with the electromagnetic field. The matter field may be quantized by treating the root fields as independent anti-commuting fields. The transformation to the interaction repre-

sentation is obviously unaltered and the charge and mass renormalization may be treated following Schwinger. To the order of approximation in Schwinger these renormalizations are not affected. It would seem that these methods of quantization, together with the usual treatment of the electromagnetic field, are at variance with the manifest non-local nature of the theory for the irreducible volume character of events. A.

530.145

3066. Hamiltonian mechanics of fields. R. H. GOOD, JR. *Phys. Rev.*, **93,** 239–43 (*Jan.* 1, 1954).

In relativistic field mechanics one ordinarily introduces the time derivative of a field component as its velocity and the partial derivative of the Lagrangian density with respect to the velocity as its canonically conjugate momentum. In order to treat the time and space equivalently, Born and Weyl once treated the four space-time derivatives of a field component as four velocities and introduced the four partial derivatives of the Lagrangian density with respect to the velocities as four momenta. In the present paper this idea is carried further in order to introduce the generalizations of the point-mechanics ideas of Hamiltonian equations, Lagrange brackets, Poisson brackets and integrals of motion. A.

530.145

3067. On a theorem in non-local field theories. P. GULMANELLI. *Nuovo Cimento*, **10,** 1582–9 (*Nov.*, 1953).

The Peierls formalism, which defines the Poisson brackets (P.B.) in a covariant way, is applied to a non-local field theory. It is shown that the P.B.'s of the ingoing and outgoing fields, defined with the Yang–Feldman method, are equal to those of the free fields. A.

530.145

3068. Quantization of a nonlinear field theory. H. B. ROSENSTOCK. *Phys. Rev.*, **93,** 331–3 (*Jan.* 15, 1954).

A quantization procedure, involving the expansion of the field in a space lattice of classical particles, is suggested for a field theory in which classical particles appear as small regions in which the field is intense. Approximate energy eigenvalues are calculated for certain values of the parameters involved. A.

530.145

3069. On the Dirac–Heisenberg theory of vacuum polarization. J. G. VALATIN. *Proc. Roy. Soc. A*, **222,** 228–39 (*March* 9, 1954).

The method of the 1934 theory of Dirac and Heisenberg is discussed and exemplified by treating the case of an external electromagnetic field. Polarization tensors are introduced which, while showing clearly the features of the well-known divergent expressions of recent calculations, are throughout well-defined in the mathematical sense. The current operator in the Heisenberg representation is calculated in the power series expansion, and the compensation of singularities in the vacuum-to-vacuum transition amplitude is indicated. A.

530.145

3070. An electric cloud in a homogeneous electric and magnetic field according to Dirac's theory. L. INFELD. *Bull. Acad. Polon. Sci. Cl.* 3, **1,** *No.* 3–4, 99–104 (1953).

The approximation method of an earlier paper [Abstr. 74 (1954)] is applied to the motion and deformation of an electron cloud between two parallel condenser plates in homogeneous electric and magnetic fields respectively. G. FIEL

530.14

3071. On quantum field theory. I. Explicit solution of Dyson's equation in electrodynamics without use of Feynman graphs. E. R. CAIANIELLO. *Nuovo Cimento*, **10,** 1634–52 (*Dec.*, 1953).

A compact, explicit expression is given for the term of arbitrary order in the power series expansion of Dyson's *S*-matrix, for any arbitrary scattering process. The expression thus found for *S* has a very high degree of symmetry (a fact which the Feynman graph technique could not reveal; the procedure is also free from several shortcomings of this technique), which suggests the existence in the theory of deeper properties. These will be studied in the continuation of this work. A

530.14

3072. Electromagnetic effects in two-nucleon systems. S. DESER. *Phys. Rev.*, **92,** 1542–7 (*Dec.* 15, 1953).

Corrections to the electromagnetic properties of two-nucleon systems are examined by means of the relativistic two-body equation. An effective addition to the potential is derived, which describes the properties of the system in an external electromagnetic field. In particular, the correction to the deuteron's quadrupole moment is evaluated to lowest order in the meson-nucleon coupling. The result, for pseudoscalar (pseudoscalar) symmetric theory, is $\Delta Q = -1\cdot3\times10^{-28}(g^2/4\pi)$ cm^2. A.

530.145 : 538.3

3073. Self-consistent electrodynamics. O. BUNEMAN. *Proc. Cambridge Phil. Soc.*, **50,** *Pt* 1, 77–96 (*Jan.*, 1954).

The idea of direct action between streams is applied to a continuous charged fluid and combined with the new formulation of the electrodynamical laws of motion in terms of conservation of circulation. A simple and rigorous integrated formulation is thus obtained from the Maxwell–Lorentz differential equations, applicable to co-existing positive and negative fluids, as well as vacuum. Exact solutions are obtained, among them one which represents self-consistent, self-maintained flow in a hollow tubular region of infinite axial extent. It is hoped this tube might be bent into a torus and that an electron model will result from merely quantizing the one or two vortices around which this flow-pattern circulates. A.

530.145 : 538.3

3074. Electrodynamics without potentials. L. INFELD AND J. PLEBANSKI. *Proc. Roy. Soc. A*, **222,** 224–7 (*March* 9, 1954).

A new more general approach to classical electrodynamics is here formulated. In it, not the electromagnetic potential (A_α) but the field ($f_{\alpha\beta}$) appears as fundamental. Field equations of a general type follow, among them Dirac's new electrodynamics as an important special case. A.

530.145

3075. On the theory of the energy spectra of quantum systems of many particles. V. L. BONCH-BRUEVICH. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 5, 711–14 (1952) *In Russian.*

A method for investigation of weak excitations; i.e., excitations in which the ratio of the number of excited particles to the total number of particles is small, is discussed. The formalism employs annihilation and creation operators, which operate on the ground state to form excited states. It is shown that this problem coincides formally with the problem of $2n$ particles. G. E. BROWN

530.145

3076. Electromagnetic shifts of energy levels and *C*-meson hypothesis. O. HARA. Letter in *Progr. theor. Phys.*, **9**, 322–3 (*March*, 1953).

An explanation of the discrepancy (~0·5 Mc/s) remaining between theoretical and experimental values of the Lamb shift is offered in terms of the potential between electron and proton arising from the *C*-meson. G. E. BROWN

530.145

3077. Renormalised two particle potential from field theory. W. MACKE. Letter in *Nuovo Cimento*, **10**, 1198–1200 (*Aug.*, 1953).

A renormalization procedure for the Bethe–Salpeter equation is proposed, involving the addition of further terms to the interaction part of the Hamiltonian.

G. FIELD

530.145

3078. On annihilated photons and electromagnetic interactions. S. SLANSKY. *C.R. Acad. Sci.* [*Paris*] **237**, 972–3 (*Oct.* 28, 1953) *In French.*

A study of certain properties of the "number of annihilated photons" [L. de Broglie, *Mécanique ondulatoire du photon et théorie quantique des champs. Paris* (1949).] P. T. MATTHEWS

530.145

3079. Remarks on the validity of the Tamm–Dancoff method. G. MORPURGO AND B. F. TOUSCHEK. *Nuovo Cimento*, **10**, 1681–94 (*Dec.*, 1953).

An example of a field which has already been investigated by Wentzel and Blatt [Abstr. 6458 (1953); 3424 (1947)] is discussed in detail. The exact solution of the problem corresponding to the scattering of a meson by a nucleon is compared with that obtained by the first approximation of the Tamm–Dancoff method. It is found that this method leads to results, which, though better than those obtained in perturbation theory are essentially qualitative. The disagreement is particularly strong, if the coupling constant is nearly sufficient to give rise to bound states. A.

530.145

3080. Equivalent mass and other effects of a non-local electromagnetic field in interaction with a constant *E*, *H* field. C. GREGORY. *Phys. Rev.*, **92**, 1554–7 (*Dec.* 15, 1953).

Some consequences of the interaction of a non-local photon with a constant E, H field are considered. The interaction is shown to vanish in the limit of local fields independently of the magnitude of the coupling constant g, so that results obtained could be traced directly to the assumption of a non-local field. An exact solution for the non-local field is obtained as a sum of non-local plane waves containing the four-vector q_μ. It is shown that this four-vector in conjunction with the coupling constant plays two rôles. In one it is involved in the expression for an electric dipole moment: $g\mathbf{q}$ and in the other in an expression for a magnetic dipole with moment: $g/2(\mathbf{q}\times\mathbf{k})/|k|$, where $\mathbf{k}/|k|$ is the propagation vector. This identification gives significance to the C numbers, q_s appearing in the theory. The equivalent mass μ, averaged over orientations of $\mathbf{q}$ for which $\mu^2 > 0$, turns out to be of order $4\cdot0\times10^{-12}(\gamma B/\lambda)^{\frac{1}{2}}$ electron masses, where γ is the number of Bohr magnetons; $|g\mathbf{q}|mc/he$, λ is the wavelength, and B is an upper limit to the magnitude of the external field in Gaussian units. An order of magnitude measure of the optical properties of the region containing the constant E, H field which affects the non-local photon is $|n-1| = 3\cdot2\times10^{-4}(\lambda\gamma B)$, where n is an upper limit to the index of refraction. For pronounced, measurable effects, say, $|n-1| \simeq 0\cdot1$ implies that $\langle\mu\rangle/m$ attains a value of $10^{-10}/\lambda$ electron mass. A.

530.145 : 539.18

3081. Radiative corrections in the decay of μ-mesons. E. M. LIPMANOV. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 6, 999–1001 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-139.

Corrections to the decay into an electron and two neutrinos are calculated for the five interactions (scalar, vector, etc.) which can be renormalized. An expression is only given explicitly for the scalar interaction, though the others are reported to give similar results. For the most probable decay-electron energy, these corrections are ~10% of the zero-order expression. It is pointed out that experiments to date would not distinguish between decay into three particles without and with emission of a real photon. The probability of the latter case is calculated and added to the radiative correction described above, leaving only a 0·5% correction to the zero-order probability. G. E. BROWN

530.145

3082. About the connection between the theory of regularization and the theory of particles with arbitrary spin. YU. A. YAPPA. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 1, 51–4 (1952) *In Russian.*

The equivalence of the Pauli–Villars "regularization" procedure to the use of field equations with higher derivatives is sketched. The equations derived from both of these procedures are shown to be equivalent to a field equation describing: (1) either an assemblage of particles, the spins of which may be the same or different, and the masses of which are arbitrary (2) or a particle possessing different spin states and with a definite mass corresponding to each spin state. The manner in which one obtains Green's functions for all field equations mentioned above is sketched. G. E. BROWN

530.145

3083. Hypothesis of a new particle, the electrino. D. IVANENKO AND N. KOLESNIKOV. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 6, 923–5 (1952) *In Russian.*

The existence of the electrino, a fusion of electron and neutrino with mass two to four times the electron

mass, is proposed. Ordinary β-decay can be treated as a virtual decay of the electrino, into electron and neutrino. In some cases β-decay by way of an electrino can compete with ordinary β-decay; i.e., if the energy of β-decay is slightly greater than the rest mass energy of the electrino. For much higher energies, ordinary β-decay predominates because of the stronger dependence of the probability on energy.

G. E. BROWN

530.145

3084. The derivation of Vlasov's equation from Fock's equation. J. ŁOPUSZAŃSKI. Letter in *Acta phys. Polon.*, **11,** *No.* 2, 196–9 (1952).

The plasma equation is derived with the aid of Dirac's density matrix. The transition to classical mechanics is made with Bohr's correspondence principle for the case of large numbers of particles, and neglect of spin variables except for exchange of electrons of parallel spin. F. ANSBACHER

530.145

3085. On the isotopic spin of elementary particles. V. VOTRUBA AND M. LOKAJÍČEK. *Czech J. Phys.*, **2,** 1–12 (1953).

It is shown that the electron, the positron and the Majorana neutrino can be described jointly as three charge states of a single particle, the lepton, which in contrast to the nucleon is an elementary particle with isotopic spin 1. Similarly, the mesons $\pi^{\pm}$ and π^{0} are described jointly as three charge states of a single particle, the pion, with isotopic spin 1. Interactions of the lepton field (and also of the pion field) with the electromagnetic field and with the nucleon field are considered. The whole theory is shown to be independent of any special choice of the representation of the isotopic spin operators. A.

530.145

3086. Is the Dirac process of linearization necessary? V. S. VRKLJAN. *Proc. Indian Acad. Sci. A*, **37,** 491–8 (*April*, 1953) *In German.*

It is shown that the usual process is not necessary. A modification is introduced which leads to the spin of the electron (or positron) and also the magnetic moment. The latter is discussed on the basis of two methods: (1) that of Darwin, (2) that of wave-packets. L. S. GODDARD

530.145

3087. Non-local field theory based on the Salpeter–Bethe equation. I. 'Free' particles. H. L. JORDAN AND W. E. FRAHN. *Z. Naturforsch.*, **8a,** 620–8 (*Oct.*, 1953) *In German.*

A theory of free particles is based on a suitable limit of the Salpeter–Bethe relativistic two-particle equation [Abstr. 1469 (1952)] and the simplest irreducible fourth-order graphs are discussed. The free particle so defined satisfies a generalized Dirac equation with structure function, which suggests a possible theory of the masses of elementary particles. This equation is of the same form as those obtained from non-local theories. P. T. MATTHEWS

530.145

3088. Spinor theory of elementary particles. I. Bases of the modified theory. F. CAP. *Z. Naturforsch.*, **8a,** 740–4 (*Nov.*, 1953) *In German.*

The hypothesis that a free particle with spin s can be described by $2(2s + 1)$ complex or $4(2s +$ real quantities, where s is the spin of the particle, stated and explained. The former number corr sponds to the number of degrees of freedom of elementary particle in terms of spin and charge. T usual spinor theory is discussed and the reduction superfluous quantities indicated. G. E. BROW

530.1

3089. Spinor theory of elementary particles. I Mathematical proof of the postulated description $2(2s + 1)$, or $4(2s + 1)$ real, wave functions. DONNERT. *Z. Naturforsch.*, **8a,** 745–7 (*Nov.*, 195 *In German.*

The hypothesis of Cap in Pt I that a free partic with spin s can be described by $2(2s + 1)$ complex $4(2s + 1)$ real quantities is proved. G. E. BROW

530.1

3090. Spinor theory of elementary particles. II The free particle. F. CAP. *Z. Naturforsch.*, **8a,** 748– (*Nov.*, 1953) *In German.*

Physical consequences of the theory discussed Pts I and II are outlined. The current and th energy-momentum tensor are constructed directly terms of spinors. The formal treatment of th Fermi–Dirac and Bose–Einstein fields is identica up to the point of quantization of the fields.

G. E. BROW

530.14

3091. The scattering of a charged Dirac particle b an electrostatic scattering centre. P. ROUSSOPOULOS *C.R. Acad. Sci.* [*Paris*] **237,** 1397–9 (*Nov.* 30, 195 *In French.*

The transition probability from one momentun state to another is calculated using the variationa method of Lippmann and Schwinger [Abstr. 849 (1950)]. P. T. MATTHEW

530.14

3092. Mass quantization and isotopic spin in non local field theory. J. RAYSKI. *Nuovo Cimento*, **10** 1729–35 (*Dec.*, 1953).

Starting from general remarks on the theory c fields, the local formulation of which seems to b insufficient, the author presents a non-local generaliza tion of the Dirac equation that leads, by means c convenient supplementary conditions, to a mas spectrum for the particles of spin $\frac{1}{2}$. The analogie of this mass spectrum with those obtained from th Yukawa and Pais theories are discussed. A

530.14

3093. A theory of the electron. H. T. FLINT AN E. M. WILLIAMSON. *Nuovo Cimento*, **11,** 188–9 (*Feb.*, 1954).

A theory of the electron is proposed by analog with the gravitational theory of matter. It is essentiall a classical theory based upon equations of the form suggested by Mie. The use of five-dimensiona analysis results naturally in the appearance of a fiel of the Yukawa vector type in addition to the electro magnetic field. The theory of the electron is thu brought into line with theories of the nuclear field The analogy leads directly to the results obtained b Bopp and accounts for the mass of the electron b means of the energy of the field. A

530.145

3094. Singularities of electron kernel functions in an external electromagnetic field. J. G. VALATIN. *Proc. Roy. Soc. A*, **222**, 93–108 (*Feb.* 23, 1954).

The electron kernel functions are derived from solutions of the second-order wave equation, using the proper-time parametrization. Iterated kernel functions are introduced and a gauge-independent perturbation theory is developed. The separation of singular parts proceeds in terms of the iterated kernel functions valid in the absence of an electromagnetic field, and the singular expressions which have to be compensated in order to determine the physically significant part of the vacuum polarization are obtained in a more transparent form than those given originally by Heisenberg. A.

530.145

3095. Long range nuclear forces. H. C. CORBEN. Letter in *Nuovo Cimento*, **10**, 1485 (*Oct.*, 1953).

It is suggested that the $1/r$ type potential between nucleons or electrons, due to the exchange of virtual neutrinos, which is implied by the Fermi theory of β decay, may be responsible for, or actually greater than, the observed gravitational potential. Formally this effect is infinite and unrenormalizable.

P. T. MATTHEWS

530.145

3096. On the convergence of the Born approximation method. P. URBAN AND K. WILDERMUTH. *Z. Naturforsch.*, **8a**, 594–8 (*Oct.*, 1953) *In German.*

The conditions for convergence are found for the special cases of scattering in a Coulomb field with cut-off, scattering of spin-zero particles by a potential well, and one-dimensional three-body scattering (with infinitely heavy scatterer). By expansion of the phase factor in powers of the coupling constant the dependence of the region of convergence on the energy of the incident particles and on the scattering potential is found. G. FIELD

530.145

3097. On the spectra of μ-mesohydrogen. A. D. GALANIN AND I. YA. POMERANCHUK. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 2, 251–3 (1952) *In Russian.*

The fine-structure of the negative μ-meson captured in an orbit about the nucleus is considered. Since the inner meson orbits are within the electron Compton wavelength, the polarization of the vacuum is large. It is, in fact, of order α, and is calculated. For $Z = 6$, the effect on the $2S$ level is 47 eV and on the $2P$ level, 27 eV. This tends to reduce the splitting of the $2P$ and $2S$ levels arising from the finite size of the nucleus and the remaining splitting is estimated to be 40 eV. This splitting is used as an explanation of the absence of Auger electrons, which might arise in the $2S$–$1S$ transition (since this transition is forbidden optically), but which are not found in experiment. An electron can make a transition from the $2S$ level to the $2P$ and from there go optically to the $1S$. Emitted electrons will be of low energy. It is also pointed out that observations on the fine-structure will determine whether other fields than the electron-positron field contribute to the polarization of the vacuum. G. E. BROWN

530.145

3098. On the theory of elementary particles. YA. B. ZEL'DOVICH. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 3, 505–8 (1952) *In Russian.*

The concept of a "nuclear charge" is introduced, and defined to be $+y$ for a proton or a neutron and $-y$ for an anti-proton or anti-neutron. The conservation of this nuclear charge is postulated. Since a neutral V-particle decays into a proton and π-meson, it must have a nuclear charge of $+y$. The existence of an anti-V-particle is assumed, and various decay schemes for the V- and anti-V-particles are investigated. Some are ruled out by the above conservation law. G. E. BROWN

530.145

3099. Variation principles and the virial theorem for problems of continuous spectra in quantum mechanics. YU. N. DEMKOV. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 2, 249–52 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-21.

Mathematical. For discrete spectra the variation of the unit of length leads to the virial theorem. A generalization gives the application to continuous spectra, and to problems of collision or of plane wave diffraction under certain conditions. J. JACOBS

530.145

3100. On the theory of strong binding for meson fields. B. T. GEĬLIKMAN. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 6, 991–4 (1953) *In Russian.*

The formalism for strong binding developed in [Abstr. 8233 (1953)] is extended to the case of mesons interacting with bodies of finite mass and considered in more detail for pseudoscalar binding. Differences of the results from those of other theories of strong binding are discussed. G. E. BROWN

530.145

3101. On the two types of charge invariance. A. BALDIN AND V. MIKHAĬLOV. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 3, 479–82 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-101.

Discussing the photoproduction of π^0 mesons on deuterons, the authors show that the assumption of charge symmetry is sufficient for the formulation of selection rules for the reaction $\gamma + d \rightarrow d + \pi^0$. Treating the interactions with the electromagnetic field as small, the interaction part of the Hamiltonian can, both for charge symmetry and charge independence, be split into two parts, S and V_3, where S, which depends only on the interaction of the electromagnetic field with the nucleon charge, is invariant under a 180° rotation around the 1-axis in isotopic spin space (i.s.s.), whereas V_3 changes sign. From the general transformation properties of the transition matrix element it follows that the meson wave function can either be a scalar (ϕ_0) or a third vector component (ϕ_3) in i.s.s. If nucleon recoil effects are neglected, the process is forbidden for ϕ_0, but no such selection rule operates for ϕ_3 or for the alternative reaction $\gamma + d \rightarrow n + p + \pi^0$. Taking recoil into account, the assumption $S \sim V_3 \cdot \mu/M$ (μ, M are the π^0 and nucleon mass resp.) leads to cross-sections for forbidden processes ~40 times smaller than those for allowed ones. The general conclusions are indepen-

dent of any assumption regarding the strength of mesonnucleon coupling and the nature of the meson field. A result of this investigation is that $g_N = -g_P$ does not imply charge independence, but merely proves charge symmetry. G. FIELD

530.145

3102. On the interaction cross-section of very fast nucleons. E. L. FEĬNBERG AND D. S. CHERNAVSKIĬ. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 3, 511–13 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-*111.

Remarks on some modifications to Heisenberg's classical hydrodynamical theory of meson production (1952) due to quantum effects, important for distant collisions. The consequences would be an approx. geometrical cross-section independent of energy and excitations of the nucleus not sensitive to the impact parameter. W. J. SWIATECKI

530.145

3103. A study of the interaction between particle and homogeneous and constant electromagnetic fields. M. DEMEUR. *Mém. Acad. Roy. Belgique Cl. Sci.*, **28**, *No.* 5, 98 *pp.* (1953) *In French.*

After an introductory historical survey of the development of field theory, the author discusses the Schrödinger, Heisenberg and interaction representations. He then introduces the bound interaction representation with which the remainder of the article is concerned. In this representation the vacuum polarization appears as the mean value of the current for vacuum. For an external field which does not produce vacuum polarizations, charge renormalization is not necessary. For a homogeneous and constant electromagnetic field the operators (and corresponding commutators) can be obtained without approximations and thus the total radiative correction calculated. The problem of finding regular and singular solutions of the field equations is solved for the cases of spin-O and spin-$\frac{1}{2}$ particles in constant and homogeneous external electric and magnetic fields. Properties of these solutions are studied and Fourier representations of the singular solutions obtained. As applications of the method, the anomalous magnetic moments of nucleons (with pseudoscalar meson fields) are calculated. Finite results are obtained in the form of rapidly converging series in powers of the external field. The corresponding electron case is treated, where the correction cannot be expanded in series form.

G. FIELD

530.145

3104. Scattering of pions by nucleons. M. LOKAJÍČEK. *Czech. J. Phys.*, **2**, 13–17 (1953).

The mesons $\pi^{\pm}$, π° and π' (neutral meson with isotopic spin 0) are described jointly as charge states of a single pion the isotopic spin of which may be 1 and 0. The fundamental equations of the pion field interacting with the electromagnetic and the nucleon fields are formulated. The Hamiltonian describing the interaction of the pion field with the nucleon field is limited only by the requirement of the conservation of charge. Symmetrical and other kinds of coupling are special cases. From the Hamiltonian, the pion-nucleon scattering matrix is deduced. A.

530.14

3105. Meson nucleon scattering. S. GOTO. Lette in *Progr. theor. Phys.*, **9**, 91–2 (*Jan.*, 1953).

A modified form for Dyson's S_F' propagator is use for the calculation of $\pi^+ - p$ and $\pi^- - p$ scatterin cross-sections (σ_+ and σ_-) in pseudoscalar theor with pseudovector coupling. The differential cross sections do not agree with experimental results i their angular dependence, σ_+ has a singularity, an for total cross-sections, $\sigma_+ > \sigma_-$. G. FIEL

530.14

3106. On some properties of the interaction between elementary particles. S. ÔNEDA. *Progr. theor. Phys.*, **9**, 327–44 (*April*, 1953).

To secure sufficient stability of matter a law o conservation of heavy particles is postulated. From this postulate, a sort of intrinsic charge called nucleonic charge is assigned to every elementary particle uniquely. By analogy with electric charge the law can be stated as the conservation law o nucleonic charge, the properties of this charge are investigated. Using this charge and recently obtained knowledge about heavy mesons, the possible existence of families of elementary particles is presented. The interactions between families which seem to have primary importance are discussed. Bearing the conservation law of nucleonic charge in mind, the production mechanism of heavy mesons is analysed, and the necessity of the ordering of the interactions between families is stressed. Heavy mesons and threshold energies of production are discussed. A.

530.145

3107. On the scattering problem in pseudo-scalar meson in pseudo-vector coupling. K. SAWADA. *Progr. theor. Phys.*, **9**, 455–67 (*April*, 1953).

The theoretical investigation of meson-nucleon scattering given by Brueckner [Abstr. 4631 (1952)] which fits very well with the experimental data is based on phenomenological considerations with the mixed use of weak and strong coupling theories. The weak coupling treatment was abandoned owing to its failure to explain the well-known scattering data even qualitatively. These weak coupling calculations are in Born approximation. The well-known threshold rise of the cross-section is given by pseudoscalar meson with pseudovector coupling, but there is no assurance that the Born approximation is allowed. In the weak coupling case, the effective-scattering Hamiltonian can be easily obtained by a canonical transformation (for example, assuming the coupling to be weak, retain only the second-order term), but if one regards this as a "potential" which causes meson scattering, the singularity of this "potential" is so strong that the Born approximation is unnecessary, and just as in the theory of nuclear force one should solve the problem exactly with this "potential." (The word "potential" does not mean that the meson scattering can be represented by potential scattering; the quantity which appears in place of potential is here called "potential.") The "potential" under the weak coupling assumption is calculated and the dynamical problem of the system is solved correctly (not in Born approximation) for the problem of meson-nucleon scattering. This is the

method so far used in the meson theory of nuclear force, i.e. deriving the nuclear potential under the weak coupling assumption and solving the Schrödinger equation with this potential exactly; the authors want to perform the same procedure in the meson-nucleon scattering. The "potential" derived from pseudoscalar meson with pseudovector coupling is very singular and changes its sign and magnitude for different total isotopic spin and angular momentum of the system. It is seen that virtual level resonance takes place for $I = 3/2$ and $J = 3/2$ state. The conclusion is roughly the same as in Brueckner's theory. Divergences appear but can be summed up to the effective coupling constant apart from the position of virtual level. A.

530.145

3108. The general theory of the interaction representation. II. General fields and interactions. H. Umezawa and Y. Takahashi. *Progr. theor. Phys.*, **9**, 501–23 (*May*, 1953).

For Pt I, see Abstr. 1045 (1954). In the case when the interaction contains higher derivatives than the free part the method of the previous paper is extended. It is shown that the formalism is perfectly equivalent to the Heisenberg–Pauli method, but not to the Ostrogradski one. Lastly, the example of the quantization of non-local interaction is given. A.

530.145

3109. On the structure of the interaction of the elementary particles. IV. On the interaction of the second kind. S. Kamefuchi and H. Umezawa. *Progr. theor. Phys.*, **9**, 529–49 (*May*, 1953).

For Pt III, see Abstr. 62 (1954). By extending the method of renormalization theory and making use of the similar idea for radiation damping a possibility is examined of establishing the non-singular theory of interactions of the second kind. When using propagation functions modified by the field reaction in place of the usual one less singular theories can in general be obtained. It is shown that for a given set of interactions, some of which belong to the second kind, the non-singular theory can always be constructed if, when necessary, auxiliary interactions of the second kind are introduced. Several examples of the non-singular theory obtained in this way are given and some remarks are further added in connection with the characteristic features of this method. A.

530.145

3110. Non-local theory of interactions between Fermi particles. P. Budini and C. Villi. *Nuovo Cimento*, **10**, 1172–86 (*Aug.*, 1953) *In Italian.*

A covariant non-local formulation of the interaction between Fermi particles is described, and the first two terms in the S-matrix expansion given. As an application, the K-capture of a μ^--meson is discussed and capture life times for local and non-local interactions are compared. G. FIELD

530.145

3111. The formulation of the Kohn–Hulthén variational principle in terms of the scattering operator formalism. H. E. Moses. *Phys. Rev.*, **92**, 817–21 (*Nov.* 1, 1953).

The Kohn–Hulthén variational principle is expressed in terms of the scattering operator formalism. It is shown that in terms of this formalism the principle can be expressed more abstractly and concisely than heretofore. Furthermore, certain ambiguities in the usual formulation of the principle have been removed. A.

530.145

3112. On the calculation of the scattering of particles of spin $\hbar/2$ by a radial pseudoscalar potential. G. Petiau. *J. Phys. Radium*, **14**, 648–56 (*Dec.*, 1953) *In French.*

The scattering of particles obeying Dirac's equation is calculated for a pseudoscalar potential which is constant $r < R$ and zero $r > R$, and for a pseudoscalar potential β/r, where β is Dirac's matrix. G. E. BROWN

530.145

3113. On the scattering theory of relativistic equations. E. Corinaldesi. *Nuovo Cimento*, **10**, 1673–80 (*Dec.*, 1953).

Parzen's method [Abstr. 1106 (1951)] of evaluating the phase shift at infinite energies is extended to the case when the potential has a pole at the origin. A.

530.145

3114. Adiabatic nuclear potential for large values of the coupling constant. M. Cini and S. Fubini. *Nuovo Cimento*, **10**, 1695–703 (*Dec.*, 1953).

A method for the calculation of the adiabatic potential between two fixed nucleons is proposed giving a sequence of approximations in which at each stage only a limited number of mesons and pairs is taken into account. By means of a variational principle the adiabatic potential is approximated with a sequence of fractions of polynomials in g^2, whose coefficients contain only the potentials calculated by Lévy and Klein with perturbation methods. The convergence of the sequence does not depend on the magnitude of the coupling constant and, when the limit exists, it is an analytic continuation of the series in powers of g^2 outside its radius of convergence. A.

530.145

3115. Yukawa forces with added attractions. J. M. Blatt and M. H. Kalos. *Phys. Rev.*, **92**, 1563–6 (*Dec.* 15, 1953).

A Yukawa potential is defined here as the conventional second-order potential of pseudoscalar meson theory with pseudoscalar coupling, cut off by a hard repulsive core. The authors have carried out many calculations of the properties of the neutron-proton system at low energies assuming that the interaction is this Yukawa potential with various additional spin independent central wells. The results indicate that interactions of this type (including the Lévy potential) do not give a satisfactory fit to the low-energy data. A.

530.145

3116. The scattering of many-particle systems. S. Tamor. *Phys. Rev.*, **93**, 227–8 (*Jan.*1, 1954).

In the treatment of scattering processes involving more than two particles, one frequently makes use of the impulse approximation to describe the scattering as a super-position of two-body collisions. It is shown that where the impulse approximation is valid, use of the Racah formalism enables one to effect a formal reduction of the many-body process to one involving

two bodies. The method is worked out in detail for the three-body problem. A.

530.145

3117. An identity for the *S* matrix for a finite time interval. J. C. POLKINGHORNE. *Phys. Rev.*, **93**, 228–9 (*Jan.* 1, 1954).

An identity is obtained for the *S* matrix for a finite time interval that expresses the "scale-free" character of quantum field theory. A.

530.145

3118. A theorem on photomeson production near threshold and the suppression of pairs in pseudoscalar meson theory. N. M. KROLL AND M. A. RUDERMAN. *Phys. Rev.*, **93**, 233–8 (*Jan.* 1, 1954).

It is shown that the photoproduction of charged pseudoscalar mesons at threshold computed to lowest order in the meson-nucleon mass ratio but to arbitrary order in the meson-nucleon coupling constant is essentially equivalent to the weak-coupling result obtained from second-order perturbation theory. The μ/M corrections can be estimated from the ratio of the positive to the negative production cross-section. It is therefore suggested that the measurement of the *S*-wave photoproduction of charged mesons may be one of the more reliable methods at present available for determining the meson-nucleon coupling constant. As the threshold production proceeds entirely through the mediation of negative energy states the connection of this result with the possible suppression of nucleon anti-nucleon pairs is discussed. A.

530.145

3119. One of Schwinger's variational principles for scattering. G. F. CHEW. *Phys. Rev.*, **93**, 341–3 (*Jan.* 15, 1954).

An approximation method for scattering calculations, based on a variational principle invented by Schwinger, is discussed. The method is tractable even for interactions, such as the pion-nucleon, which are not diagonal in configuration space. Criteria of validity for the approximation are proposed and made plausible by examples. A.

530.145

3120. Investigation of triplet neutron-proton scattering in the low energy region using the Eckart and Bargmann potentials. J. S. TURNER. *Proc. Phys. Soc.* [*London*] *A*, **67**, 111–16 (*Feb.*, 1954).

It is pointed out that the extension of some results obtained for a special form of potential by Bargmann [Abstr. 63 (1950)] leads to an especially simple expression for the asymptotic phase of the scattered *S* waves. The expansion of $k \cot \eta_0$ in terms of energy contains two terms only, the third coefficient *P* and all later coefficients being identically zero. The procedure for fitting experimental results is easier since the unmodified effective range theory is now exact for the Bargmann potentials. Graphs are drawn to illustrate the types of potential chosen by this method and to compare them with the conventional forms. Other Bargmann potentials for which *P* is not zero are discussed more briefly and fitted to the low-energy data, and some conclusions are drawn about the implications of the coefficient *P*. A.

530.145

3121. Non perturbation treatment of scattering in quantum field theory. M. CINI AND S. FUBINI. *Nuovo Cimento*, **11**, 142–52 (*Feb.*, 1954).

A sequence of approximations to the *S* and *K* operators is obtained by means of a variational method. The form of the approximations is such that discussions on general questions like convergence and renormalization become possible without any weak coupling assumption. The method is particularly suited for the study of two-body collision problems; in this case the difficulties in the treatment of the higher-order approximations are reduced to the problem of evaluating the perturbation *S*-matrix elements. A.

530.145 : 537.533.75 : 537.534.75

3122. The resolution in *n*th approximation of multiple scattering problems. R. MERTENS. *C.R. Acad. Sci.* [*Paris*] **237**, 1644–5 (*Dec.* 21, 1953) *In French.*

See Abstr. 6476 (1953).

530.145 : 539.152.1

3123. Meson-deuteron reaction and nucleon isobars. S. MATSUYAMA AND H. MIYAZAWA. *Progr. theor. Phys.*, **9**, 492–500 (*May*, 1953).

The meso-disintegration of deuterons and the scattering of π-mesons by deuterons are discussed, introducing the nucleon isobars rather phenomenologically. Agreement with experiment is satisfactory in the case of meso-disintegration, and the deviations from impulse approximation in the case of scattering are in the right direction. A.

530.145

3124. Difficulty of divergence of the perturbation method in the quantum field theory. R. UTIYAMA AND T. IMAMURA. *Progr. theor. Phys.*, **9**, 431–54 (*April*, 1953).

The behaviour of the *S*-matrices is investigated in the cases of the systems with Lagrangians. The series-representation of *S* in powers of the coupling constant diverges though each term of this series is finite by virtue of the non-local form factor. The divergence of this series results from the fact that the number of graphs corresponding to the *n*th term increases rapidly with the increase in *n*. The number of graphs is estimated by taking advantage of the "Green-function." A.

530.145

3125. On the relativistic two-body problem in quantum mechanics. I. W. MACKE. *Z. Naturforsch.*, **8a**, 599–615 (*Oct.*, 1953) *In German.*

The generalized Bethe–Salpeter equation [Abstr. 1469 (1952)] for bound states is transformed into a 4-component equation, which is not covariant, by using a single time description. This equation agrees with that of Tamm–Dancoff–Lévy [Abstr. 6264 (1950); 38 (1953)], obtained by a different method, apart from some characteristic differences in the interaction, notably absence of divergent vacuum graphs. The method permits renormalization free from divergencies. For a given meson theory of interaction the potential for the two particles can be obtained in powers of the coupling constants from a system of graphs. F. ANSBACHER

530.145

3126. On the relativistic two-body problem in quantum mechanics. II. W. MACKE. *Z. Naturforsch.*, **8a**, 615–20 (*Oct.*, 1953) *In German.*

New representations of the 4-component wave equation of Pt I are obtained by general transformations, in particular that of Tamm–Dancoff–Lévy. Differences in the wave function for the latter equation and that of the author appear in the 6th order of the coupling constants. F. ANSBACHER

530.145 : 537.12

3127. Non-relativistic quantum mechanics of the rigid electron. L. WALDMANN. *Z. Naturforsch.*, **8a**, 583–93 (*Oct.*, 1953) *In German.*

The equation of motion of the rigid electron of finite size contains not only the acceleration but also its time differentials. Taking account of the second differential leads to a correction of the Schrödinger equation, and its effects are discussed in detail. For the Lamb shift in the hydrogen levels it yields an expression which, on giving a suitable value to an undetermined constant factor in it, agrees with experiment and with the expressions obtained by other treatments. P. M. DAVIDSON

530.145

3128. A statistical generalization of the quantum mechanics. I. M. SCHÖNBERG. *Nuovo Cimento*, **10**, 1499–539 (*Nov.*, 1953).

It is shown that the ordinary Schrödinger equation for a dynamical system Σ may be replaced by a more general equation, which has the form of the Schrödinger equation of a quantized Bose field whose quanta are the systems Σ. The linear wave functionals of the quantized field describe pure states of the system Σ and the non-linear wave functionals describe, in general, mixtures of states of Σ. The representation in which the emission operators of the quantized Σ field are diagonal plays a central role in the present formalism. It is shown that the eigenfunctionals of the absorption operators of the quantized Σ field can be used to obtain a new description of the states of a system Σ, the expectation values of the field quantities in suitably chosen eigenstates of the emission operators coinciding with the expectation values of the corresponding quantities in the pure states of Σ, but the fluctuations being larger in the former case. The eigenfunctionals of the absorption operators have the remarkable property of being matrix elements of the unity operator of the field formalism, and seem to be of a more fundamental nature than the linear functionals which correspond to the ordinary description of the pure states by means of the wave functions of Σ. A.

530.145

3129. Space-time representation in wave mechanics. E. J. HELLUND AND M. K. BRACHMAN. *Phys. Rev.*, **92**, 822–4 (*Nov.* 1, 1953).

A Newtonian-like basis for describing the dynamical behaviour of a system is presented. The nature of the correspondence with a Boltzmann type statistical mechanics is shown. Application of elementary transformation theory is used to effect the results. A.

530.145

3130. A Stokes parameter technique for the treatment of polarization in quantum mechanics. U. FANO. *Phys. Rev.*, **93**, 121–3 (*Jan.* 1, 1954).

A technique is presented which adapts the Stokes method to quantum mechanics and serves to calculate polarization effects by means of Pauli matrices. Illustrative examples indicate that this technique may be not only convenient mathematically but also physically more transparent than previous methods. A.

530.145

3131. A variation principle for eigenfunctions. L. C. BIEDENHARN AND J. M. BLATT. *Phys. Rev.*, **93**, 230–2 (*Jan.* 1, 1954).

The usual Rayleigh–Ritz variation principle for eigenvalues is extended to give a variation principle for the eigenfunctions themselves. A.

530.145

3132. An augmented plane-wave method for the periodic potential problem. II. M. M. SAFFREN AND J. C. SLATER. *Phys. Rev.*, **92**, 1126–8 (*Dec.* 1, 1953).

For Pt I, see Abstr. 2042 (1954). It is shown that the augmented plane-wave method recently proposed can be given an alternative interpretation which leads to a much simpler analytical formulation. A plane wave of energy E_0 outside the spherical atoms is joined continuously, but with a derivative which is discontinuous, to spherical solutions of Schrödinger's equation inside the spherical atoms, corresponding to an energy E, to be determined. The expectation value of the energy is computed for this combined wave function, consisting of contributions from the plane wave region, the spherical atoms, and also a surface contribution from the surface of the sphere, since the discontinuous derivative is equivalent to an infinite Laplacian which integrates to a finite contribution over the sphere. E is now regarded as a parameter, and varied to make the expectation value of energy stationary. The resulting wave function is proved to be identical with that set up in Pt I. Furthermore, the energy E inside the spheres proves to be identical with the expectation value of the energy, so that the functions are exact solutions of Schrödinger's equation inside the sphere, but not outside the sphere, since the energy of the plane wave, E_0, is different from E. However, this discrepancy is just cancelled in the expectation value of energy by the surface integral. The resulting formulae for energy and wave function are much more convenient to use than those in Pt I. A.

530.145

3133. Bhabha's equation for a particle of two mass states in Rarita–Schwinger form. K. K. GUPTA. *Proc. Roy. Soc. A*, **222**, 118–27 (*Feb.* 23, 1954).

The irreducible relativistic wave equation for a particle having two different mass states and positive charge, given by Bhabha, has been written in a form similar to that given by Rarita and Schwinger for the Dirac–Fierz–Pauli equation for a particle of spin $\frac{3}{2}$. The components of the wave function are written as Dirac four-component wave functions, having in

addition a tensor index, and one ordinary Dirac four-component wave function. The only matrices which enter into the formulation are the Dirac matrices. An explicit representation of Bhabha's matrices in terms of the Dirac matrices is obtained. The solutions for spin $\frac{3}{2}$ are just those given by the Dirac–Fierz–Pauli equation, but the solutions for spin $\frac{1}{2}$ differ from the Dirac solutions in having additional non-vanishing components. A.

530.145 : 536.7

3134. Quantum mechanics and thermodynamic continuity. II. A. Landé. *Amer. J. Phys.*, **22**, 82–7 (*Feb.*, 1954).

For Pt I, see Abstr. 7930 (1952). The programme of deducing quantum mechanics from the postulate of thermodynamic continuity is extended to embrace the principles of symmetry and quantum statistics, in particular the rule of conservation of symmetry type when a system of N particles in resonance interaction is augmented by one more particle. The special quantitative definition of quantum conjugacy contained in the commutation rule of Born and in the Schrödinger replacement of the momentum p by a differential operator may be replaced by a general qualitative physical definition: "p and q are conjugate observables in a mechanical system when the manifold of q reactions of the system uniquely determines the manifold of its p reactions." When interpreted in terms of superposition mechanics this definition leads to the rules of Born and Schrödinger and from there to quantum dynamics. A.

530.162

3135. Relativistic equation for the quantum distribution function. Yu. L. Klimontovich. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 6, 927–30 (1952) *In Russian.*

The distribution function of statistical mechanics is put into relativistic form. Derivatives appearing in generalized Poisson brackets, which describe classical relativistic systems, are generalized to finite differences for the quantum case. Under certain conditions, the interaction of all other particles with a given one can be described by a self-consistent field in which the latter moves. The connection between the equation for the distribution function and the wave equation is discussed. G. E. Brown

530.162

3136. The dynamics of a disordered linear chain. F. J. Dyson. *Phys. Rev.*, **92**, 1331–8 (*Dec.* 15, 1953).

By a disordered chain is meant a chain of one-dimensional harmonic oscillators, each coupled to its nearest neighbours by harmonic forces, the inertia of each oscillator and the strength of each coupling being a random variable with a known statistical distribution law. A method is presented for calculating exactly the distribution-function of the frequencies of normal modes of vibration of such a chain, in the limit when the chain becomes infinitely long. For some special examples, in which the distribution law of the oscillator parameters is assumed to be of exponential form, the frequency spectra are calculated analytically. The theory applies equally well to a chain of masses connected by elastic springs and making mechanical vibrations, or to an electrical transmission line composed of alternating inductances and capacitances with random characteristics. A.

530.162

3137. On Bose–Einstein condensation. P. T. Landsberg. *Proc. Cambridge Phil. Soc.*, **50**, *Pt* 1, 65–76 (*Jan.*, 1954).

Contains a proof that the description of the phenomenon of Bose–Einstein condensation is the same whether (1) an open system is contemplated and treated on the basis of the grand canonical ensemble, or (2) a closed system is contemplated and treated on the basis of the canonical ensemble without recourse to the method of steepest descents, or (3) a closed system is contemplated and treated on the basis of the canonical ensemble using the method of steepest descents. Contrary to what is usually believed, it is shown that the crucial factor governing the incidence of the condensation phenomenon of a system (open or closed) having an infinity of energy levels is the density of states $N(E) \propto E^n$ for high quantum numbers, a condition for condensation being $n > 0$. These results are obtained on the basis of the following assumptions: (i) For large volumes V (*a*) all energy levels behave like $V^{-\theta}$, and (*b*) there exists a finite integer M such that it is justifiable to put for the jth energy level $E_j = cV^{-\theta}j^{\tau}$, and to use the continuous spectrum approximation, whenever $j \geqslant M$; c, θ, τ are positive constants. (ii) All results are evaluated in the limit in which the volume of the gas is allowed to tend to infinity, keeping the volume density of particles a finite and non-zero constant. The present paper also serves to co-ordinate much of previously published work, and corrects a current misconception regarding the method of steepest descents. A.

530.162

3138. Solution of a non-isotropic random flight problem in the case of a non-isotropic point source. C. C. Grosjean. *Nuovo Cimento*, **11**, 11–40 (*Jan.*, 1954).

In connection with the calculation of the perturbation caused by a thin circular detector in a thermal neutron flux, the following problem is solved. Given a point source whose strength is described by an isotropic distribution plus a non-isotropic cosine term, and a single scattering law containing one non-isotropic term, it is required to calculate the neutron density and the distribution of the velocity directions in every point of space. Keeping the path probabilities arbitrary for the reason of generality, exact recurrence relations have been established between the defined probability distributions. Expanding these functions in series of spherical harmonics and making use of addition theorems involving Bessel functions and Legendre polynomials, it has been possible to transform the integral relations to simple linear equations. The final results are obtained in the form of integrals which can be calculated by numerical evaluation using computing machines. By introducing simplified functions under the integral signs, it is also possible to obtain good approximations for the neutron density and current. A simple example of this method is discussed in detail and the results are compared with those given by diffusion theory. A.

530.162

3139. A sound-wave description of fermion assemblies. M. R. SCHAFROTH. *Nuovo Cimento*, **11**, 53–72 (*Jan.*, 1954).

A description of assemblies of non-interacting fermions in terms of "sound-waves" is given. Additional degrees of freedom are needed for a complete determination of the system, but their contributions are expected to be small for all isotropic excitations. Special magnetic fields can also be included. The thermodynamic functions are calculated, and an application to the problem of density fluctuations is sketched. A.

530.162

3140. Distance correlations in an ideal Fermi–Dirac gas. A. B. LIDIARD. *Phil. Mag.*, **45**, 202–7 (*Feb.*, 1954).

The antisymmetry of the total wave function of a Fermi–Dirac gas leads to an apparent repulsion between the gas particles. In other words, the average probability that two particles will be found at a distance r from one another falls to zero as r tends to zero. This pair distribution function, $D(r)$, is calculated at all temperatures by means of a variation method founded on a minimum property of the free energy. It is not possible to make a straightforward calculation using Fermi–Dirac statistics on account of the integrals which arise. Instead an approximation is used which has already been employed to meet a similar difficulty in the problem of finding the influence of exchange energy on the specific heat of electrons in metals. A.

530.162

3141. Principle of the minimum entropy in information theory. H. ITÔ. *Proc. Japan Acad.*, **29**, 194–7 (*May*, 1953).

The principle of minimum entropy is used to derive the optimum value of the prediction operator. The result agrees with that obtained by Wiener's r.m.s. criterion in the limiting case only because the entropy representation contains no information on the phase. T. J. REY

530.162

3142. Observed value of the autocorrelation function. H. ITÔ. *Proc. Japan Acad.*, **29**, 198–202 (*May*, 1953).

The fluctuation of delay time in the measurement of the autocorrelation function is investigated with the aid of an ergodic theorem. It is shown that there is a loss of information by observation; the spectral density of a perfectly random ensemble yields a curve which goes down towards the high frequency region. This allows the standard delay time of the instrument to be determined and future measurements to be corrected accordingly. T. J. REY

530.162

3143. The observation theory of the stationary random process. H. ITÔ. *Proc. Japan Acad.*, **29**, 305–10 (*July*, 1953).

The author treats the cases of partial and of simultaneous observations, respectively, by applying the Gaussian transformation and variational principles to the autocorrelation function. Partial observation is shown to correspond to classical mechanics and simultaneous observation to quantum mechanics. T. J. REY

530.162 : 548.7

Statistical mechanics of two-dimensional lattices. *See Abstr.* 3989

530.162 : 621.391

3144. Further remarks on the nature of the statistical observer. D. MIDDLETON. Letter in *J. appl. Phys.*, **25**, 127 (*Jan.*, 1954).

Two types of error can occur, the results of noise and finite observation time: a type I error, of probability α, of calling noise a signal when really only noise exists in the system; and a type II error, whose probability is β, of calling signal and noise, noise alone when actually a signal is being received. The purpose of the note is to emphasize the operational distinctions between observers. T. J. REY

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.222

3145. Theory of helical springs. Determination of the Poisson number for helical springs. K. KREBS AND W. WEIDLICH. *Z. angew. Phys.*, **5**, *No.* 7, 260–7 (1953) *In German.*

The properties of the elastic helical spring can be deduced from the second derivatives of the elastic energy, U_{xx}, $U_{\phi\phi}$, $U_{x\phi}$ (x, ϕ are the co-ordinates of the end of the loaded spring). The differential spring constant (ratio of load increase to deflection increase) is $U_{xx}(1 - U_{x\phi}^2/U_{xx}U_{\phi\phi})$, the degree of coupling between the translational and torsional oscillations at resonance is $U_{x\phi}/\sqrt{U_{xx}U_{\phi\phi}}$ and the deflection $\phi(x)$ of the spring end under axial loading is given by a simple quadratic equation depending only on Poisson's ratio which may thus be determined by simple experiments. The calculations were checked by experiments on two springs. H. J. H. STARKS

531.224.4

3146. A characteristic type of instability in the large deflexions of elastic plates. III. Curved rectangular plates in axial compression. D. G. ASHWELL. *Proc. Roy. Soc. A*, **222**, 44–59 (*Feb.* 23, 1954).

The analysis of Pt I [Abstr. 7055 (1952)] is extended to deal with the case of free-edged rectangular plates having an initial curvature about an axis parallel to one pair of opposite edges and loaded by distributed bending moments applied to the straight edges and compressive forces applied to the curved edges. In particular, the stability and post-buckling behaviour of such plates subjected to the compressive forces alone is studied. The axially symmetrical buckling of thin-walled circular tubes in axial compression is also considered. Experimental plates are found to buckle at loads rather lower than those predicted. A.

531.258

3147. On the distribution of stress round the edge of a hole in a deep beam under a uniform bending moment. B. KARUNES. *Indian J. Phys.*, **27**, 373–8 (*July*, 1953).

A solution to the problem of stress concentration due to the presence of an unstressed hole of a fairly general shape in a deep plate beam under a uniform

bending moment is obtained. The solution is verified for the cases of circular and elliptic holes which are already known, and is applied to obtain some new results. A.

531.26

3148. A paradox related to Poisson's equation. G. Bandyopadhyay. **Comments on the above paradox.** A. Narasinga Rao. Letters in *Curr. Sci.*, **22,** 328, 329 (*Nov.*, 1953).

It is stated that a uniform mass distribution throughout infinite space would produce a gravitational field of zero intensity. The paradox is then $4\pi\rho \neq \nabla^2\phi$. Rao comments that for the given mass distribution there is no uniquely defined field of force and hence Poisson's equation is inapplicable. R. A. NEWING

531.38

3149. Alignment by suspension on elastic strips. J. E. C. Plainevaux. Note in *Nuovo Cimento*, **10,** 1451–60 (*Oct.*, 1953) *In French.*

After a brief review of systems used for the near rectilinear alignment of a suspended part on elastic strips, a method is described for calculating these suspensions where the strips operate in flexure along the whole of their length. The method takes account of the large deformation of the strip and enables the parasitic movement perpendicular to the principal movement to be determined. G. F. HODSMAN

531.38 : 525.36

3150. On measurements of displacements with respect to the vertical of a mass in controlled uniformly slackened movement. J. Brouet and P. Janssens. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39,** *No.* 6, 568–73 (1953) *In French.*

A description of the apparatus used and results obtained in experiments made, from a 25 m tower at Brussels University, on the deviations E–W of a 150 g spherical steel ball suspended by a supple, inextensible fibre of 0·35 mm dia. passing over a fixed pulley and fixed to a float inside a vertical 22 m tube. The height of the float is governed by the free surface of a liquid which flows out of the tube. The motion of the centre of mass of the ball is that of a Foucault pendulum of variable length. The equation of motion and its solution are given and the theoretical and experimental results compared. S. WEINTROUB

531.383 : 539.622

3151. The tippe top (topsy-turvy top). W. A. Pliskin. *Amer. J. Phys.*, **22,** 28–32 (*Jan.*, 1954).

Two fundamentally different explanations have been given in the literature to explain the "unusual" motion of a specially constructed spherical top in which rotation causes the centre of gravity of the top to rise, the top turning 180° and finally spinning on its stem like an ordinary top. This independently derived analysis shows that the force due to sliding friction is in such a direction as to result in a torque which causes the angular velocity components to vary in a way which necessitates the rising of the centre of gravity. This analysis, which emphasizes the physical picture behind the phenomenon, agrees with two previously published papers that friction plays the primary role. Some experimental evidence is given to support the present analysis. See Abstr. 2215–I (1953).

531.3

3152. On the equation for a damped pendulum under constant torque. W. D. Hayes. Note i *Z. angew. Math. Phys.*, **4,** *No.* 5, 398–401 (1953).

Using the notation of G. Seifert [*Z. angew. Mat Phys.*, **3,** 468–71 (1952)], the equation $d^2\theta/dt^2 + \alpha d\theta/dt + \sin\theta - \sin\theta_0 = 0$ (where $0 < \theta_0 \leqslant \pi/2$ gives a function $\alpha_0(\theta_0)$ with the following charac teristics: When $\alpha < \alpha_0$, a solution exists wherei $d\theta/dt$ is always positive and periodic in θ; when $\alpha \geqslant \alpha_0$, there is no solution. It is shown tha $\alpha_1 < \alpha_0 < \alpha_2$, where $\alpha_1^2 = \sqrt{(3\cos^2\theta_0 + 1)} - 2\cos\theta$ and $\alpha_2 = 2\sin\frac{1}{2}\theta_0$. The bound α_2 is smaller tha that given by Seifert. C. F. PIZZET

MECHANICAL MEASUREMENTS 531.7

531.713 : 537.533.7

The effect of the finite light sources of measuring instruments on the determination of electron diffraction ring radii. *See Abstr.* 3541

531.717 : 539.16

3153. Accuracy limitations of β-ray thickness measurement. L. Mandel; G. Syke. *Brit. J. appl Phys.*, **5,** 58–65 (*Feb.*, 1954).

The output fluctuations of β-ray thickness gauges and the limitations they impose on the accuracy of measurement are investigated. The results, based partly on theoretical work and partly on some experi ments with Tl^{204} and Sr^{90} sources, reveal a simple relation between the shape of the β-ray absorption curve and the region of greatest accuracy. It is shown phenomenologically that the statistical inac curacies are not improved by the introduction of collimating grids. Syke criticizes this conclusion and the author replies. A.

531.717.1 : 541.182.3 : 539.27

The measurement of size and concentration of air-borne dusts with the electron microscope. *See Abstr.* 2785

531.717.7

3154. The measurement of the vertex radius of curvature of parabolic surfaces with a Moffitt traversing spherometer. J. Picht. *Optik*, **10,** *No.* 11, 557–63 (1953) *In German.*

The spherometer measures the position of a central probe held in contact with the parabolic surface. The probe ends in a small sphere and the relationship between the probe position and the zone radius is derived in terms of the parameters of the parabola and the probe radius. R. W. FISH

531.717.7

3155. A precision spherometer. J. W. Gates, K. J. Habell and S. P. Middleton. *J. sci. Instrum.*, **31,** 60–3 (*Feb.*, 1954).

The instrument described has been developed from the design of Guild; it is suitable for the accurate

measurement of the curvature of transparent lenses and test plates, and particular attention has been given to protecting the surfaces measured from risk of damage. A brief comparison with other spherometers is made, and, in conclusion, attention is drawn to the convenience of specifying optical surfaces by their curvatures, rather than by radius of curvature. A.

531.752 : 621.317.49

3156. A new hydrostatic balance with magnetically suspended float. K. GROTH, M. HELLSTEN AND E. SANDEGREN. *Trans Instrum. Meas. Conf.*, **1952**, 20–1.

Kohlrausch's hydrostatic weighing method of determining density is employed using an analytical balance with a solenoid in place of one of the pans. The solenoid surrounds a glass vessel containing a float with a permanent magnet inside it, and, in the equilibrium position, the lower end of the float screens a beam of light directed to a photoelectric cell and thus regulates the current fed to the solenoid. Damping is introduced to prevent oscillation of the float. The density of the float is less than that of the liquid to be measured. When the current is switched on, the float is attracted by the solenoid and is weighed. The actual weight of the solenoid is determined with no current on and the density is computed from these readings. The method is free from the influence of external forces such as surface tension which arises when the float is supported by a thread without the magnetic balancing arrangement. The container can be filled or emptied rapidly because the suspending mechanism is robust and not delicate as in normal hydrostatic balances. A. C. WHIFFIN (R)

MECHANICS OF FLUIDS 532

532.13

3157. Variation of viscosity of liquids with temperature. S. S. MITRA. Letter in *Curr. Sci.*, **22**, 329–30 (*Nov.*, 1953).

Sutherland's theoretical viscosity temperature relation for gases is modified for liquids and the resulting formula is shown to behave very well for a number of liquids. T. C. TOYE

532.13

3158. The effect of a steady transverse field on the viscosity of polar liquid dielectrics. J. HART. Letter in *Canad. J. Phys.*, **32**, *No.* 1, 99–100 (*Jan.*, 1954).

The viscosity of a semiconducting polar organic liquid increases with time of application of a steady field across the channel through which the liquid flows [Abstr. 763 (1947)]. With amyl acetate the viscosity increases linearly with field strength, to a saturation value at 20 kV/cm. With a square wave-form of 1 c/s, instead of d.c. the viscosity continues to rise linearly with stress up to 70 kV/cm. This cannot be explained by a reduction in the effective channel depth, which would give saturation effects up to above 100 c/s. J. H. MASON

532.5 : 541.183

3159. Application of a new adsorption method in the study of flow of fluids. S. KONČAR-DJURDJEVIĆ. Letter in *Nature* [*London*] **172**, 858 (*Nov.* 7, 1953).

The object to be examined is coated with a thin layer of silica gel by spraying it with a fine suspension of the gel in an acetone solution of cellulose nitrate. The object is fastened on an Al plate and the whole placed in the stream of water containing 0·00015% of methyl violet. "Adsorption spectra" are thus produced on the plates, the intensely coloured parts corresponding to thin boundary films and therefore to high rates of flow, and conversely. S. J. GREGG

532.51

3160. Application of radioactivity to the experimental mechanics of fluids. A. HÉE AND P. KELLER. *C.R. Acad. Sci.* [*Paris*] **238**, 44–6 (*Jan.* 4, 1954) *In French.*

From a study of the distribution of atoms of RaE and RaF during spontaneous deposition, from aqueous solution, upon a nickel plate, it has been established that (1) the number of atoms deposited is a function of the local velocity of the fluid, and (2) the spontaneous deposition of a radioelement can afford evidence of currents in fluid in immediate contact with a moving obstacle. J. S. G. THOMAS

532.516

3161. Experiments in hydrodynamic lubrication using water as a lubricant. S. ABRAMOVITZ. Letter in *J. appl. Phys.*, **24**, 1521–2 (*Dec.*, 1953).

Finds that hydrodynamic lubrication may be achieved in a pivoted segmental thrust bearing, using water as lubricant, when the shoe has an optimum convex profile. J. W. MENTER

532.517

3162. Numerical solution of the Navier–Stokes equations for the flow around a circular cylinder at Reynolds number 40. M. KAWAGUTI. *J. Phys. Soc. Japan*, **8**, 747–57 (*Nov.–Dec.*, 1953).

The steady two-dimensional flow around a circular cylinder submerged in a viscous fluid for the case $R = 40$ is investigated, integrating numerically the exact Navier–Stokes equations. The main results are as follows: (i) the steady flow solution exists even for Reynolds number as high as 40. Moreover, it seems that the solution goes over smoothly to the solution of the Kirchhoff discontinuous flow theory which seems to be the limiting flow for the case $R \to \infty$; (ii) the flow pattern and the coefficients of pressure and drag are in good agreement with the experimental data. A.

532.517 : 533.6.011.311

3163. Boundary layer flow near a cylindrical obstacle in an oscillating, incompressible fluid. J. HOLTSMARK, I. JOHNSEN, T. SIKKELAND AND S. SKAVLEM. *J. Acoust. Soc. Amer.*, **26**, 26–39 (*Jan.*, 1954).

The flow in two dimensions of an oscillating incompressible fluid near a circular cylinder with its axis normal to the direction of oscillation, is studied theoretically and experimentally. Starting from the Navier–Stokes differential equations the method of suceessive approximations has been used in order to get approximative solutions, when the appropriate boundary conditions are applied. The zeroth approximation gives the modified field of oscillation near the

cylinder as a function of the viscosity. The first approximation also gives a stationary flow, which is found from the solution of an ordinary linear differential equation of 4th order. Experiments have been carried out in air in a Kundt's tube. The velocities in the plane normal to the axis of the cylinder have been found by photographing smoke particles in air. The experimental and theoretical results agree fairly well. Comparison with corresponding data obtained by Schlichting is also made. Some G functions, derived from Hankel functions which have been used in the theoretical solutions, have been tabulated to 6 digits. A.

532.517 : 538.69

3164. On the stability of viscous flow between parallel planes in the presence of a co-planar magnetic field. J. T. STUART. *Proc. Roy. Soc. A*, **221**, 189–205 (*Jan.* 21, 1954).

Linearized equations are derived which govern the stability of a viscous, electrically conducting fluid in motion between two parallel planes in the presence of a co-planar magnetic field. With one suitable approximation, which restricts the valid range of Reynolds number of the theory, the problem of stability is reduced to the solution of a fourth-order ordinary differential equation. The disturbances considered are neither amplified nor damped, but are neutral. Curves of wave numbers against Reynolds number for neutral stability are calculated for a range of values of a certain parameter, q, which represents the magnetic effects. For given physical and geometrical properties, the critical Reynolds number above which the flow is unstable rises with the strength of the magnetic field. These results are completely within the range of the approximation mentioned. In addition, an energy relation is derived which illustrates the balance between energy transferred from the basic flow to the disturbances, and that dissipated by viscosity and by the magnetic field perturbations. A.

532.517.2

3165. An example of [fluid] flow including a free stream line in a perfect fluid. Y. SHIBAOKA. *J. Inst. Polytech. Osaka City Univ. B*, **3**, 53–7 (*Oct.*, 1952).

The following case of flow of a perfect fluid is discussed: The fluid flows along a semi-infinite plate, then falls by way of a free streamline and flows over a second plane, parallel to the first, and thence through a sink in this latter plane. The analysis is based upon a transformation of the flow to the hodograph plane and thence to the ζ-plane expressed by the complex velocity potential $w(\zeta) = \log(\zeta + i\cot\alpha) + \log(\zeta - i\tan\alpha)$ where $0 < \alpha < \pi/2$. It is shown that fluid flow comprising uniform flow at infinity, with no singular point anywhere, is impossible.

J. S. G. THOMAS

532.517.3

3166. Some aspects of the change between laminar and turbulent flow of liquids in cylindrical tubes. E. R. LINDGREN. *Ark. Fys.*, 7, *Paper* 23, 293–308 (1953).

Literature relating to the change from laminar to turbulent flow in cylindrical tubes is critically reviewed, and an experimental study of the change, carried out along lines similar to those used by Schiller [*Phys. Z.*, **26**, 566 (1925)] and by Binn [Abstr. 2785 (1945)] is described and discussed. is suggested that the results indicate that it is doubtfu that the Reynolds number alone determines the sta of motion of liquids in pipes, as is currently believe though it is considered that the experiments should b repeated and extended under stricter conditions c accuracy and control. Double-refringent suspension of bentonite in distilled water, as well as pure dis tilled water, were used in the experiments. Th main conclusions are: (1) the transition betwee laminar and turbulent flow in smooth, circular pipe proceeds continuously at least up to Reynold number (R), 3300; (2) the pressure discontinuit (resistance increase) at certain values of R does no signify an instantaneous onset of turbulence; (3) th vorticity of flows with high entrance disturbance decreases with the distance travelled; this has bee observed with flows up to $R = 1\,900\,000$; (4) R i by no means a crucial variable that alone determine the transition; (5) classical experiments for deter mining the lower critical value of R have been mis interpreted, and there does not exist a critical valu of $R_K \sim 2300$; (6) in defining the state of motion i smooth cylindrical tubes, R may be replaced by an expression of the form $F[(U_0 d/\nu)(d/l)]$ where l is the distance travelled; (7) model tests with bentonite suspensions should not be performed with higher bentonite concentrations than 0·1–0·2%.

J. S. G. THOMAS

532.517.4

3167. Transport processes as foundations of the Heisenberg and Obukhoff theories of turbulence. C.-M. TCHEN. *Phys. Rev.*, **93**, 4–14 (*Jan.* 1, 1954).

The transfer of energy across the spectrum is investigated by the method of the harmonic analysis of the Navier–Stokes equation. The phase correlation which enters into the transfer is determined by the statistical considerations of transport processes. The results obtained allow a theoretical explanation to be given to the Heisenberg and Obukhoff postulates, delimiting the conditions of their applicability. By extending the above considerations of transport processes to shear flow, the production of turbulent energy from the mean flow is determined in spectral terms. As an application, the spectral laws for energy and shear are derived, and compared with measurements. A.

532.593 : 551.48.018 : 778.3

3168. A simple optical method for measuring the statistical distribution of water surface slopes. A. H. SCHOOLEY. *J. Opt. Soc. Amer.*, **44**, 37–40 (*Jan.*, 1954).

A flash-photography technique for determining the statistical distribution of slopes of wind-created waves is described. The technique consists of taking photographs with a flash camera directed vertically downward toward the water surface. The resulting photographs are flash reflection patterns that can be readily interpreted in terms of wave slopes. Wave-slope dispersion curves, as determined from daytime flash photographs taken from a bridge about 45 feet above the water, are given for wind velocities up to 20 knots. For example, the standard deviation

of the across-wind wave slopes was found to be approximately 2·5, 5 and 7·8 degrees for wind velocities of 5, 10 and 20 knots, respectively. Under the same conditions the with-wind wave-slope standard deviation was found to be 4·2, 7·5 and 10 degrees. A.

CAPILLARITY 532.6

532.612

3169. Definition of surface tension and of the free surface energy. F. O. KÖNIG. *Z. Elektrochem.*, **57**, 361–4 (*May*, 1953) *In German.*

Analyses and discusses (1) the statement that the surface tension *sensu lato* is equal to the free surface energy per unit area; (2) the necessity for taking into consideration Gibbs's definition of surface tension for the case when one of the two phases is a solid; and (3) three different magnitudes each of which is rightly defined as free surface energy. F. LACHMAN

532.65

3170. An observation of the falling of water-drops on to an oil surface. B. N. SINGH. *Z. Phys.*, **136**, *No.* 1, 105–7 (1953) *In German.*

In an earlier paper (1944) Singh and Sinha describe a technique for observing water-drops falling on to liquid surfaces. The drops sink into the liquid, as a whole, up to a certain critical height and if the height from which the drops fall exceeds this critical value the drops break up into two or more droplets. In the present paper curves are given which show the relation between this critical height and (*a*) mass of drop, (*b*) composition of the oil into which they drop, (*c*) surface pressure of the oil, (*d*) temperature, (*e*) viscosity of the oil. J. IBALL

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

3171. Molecular theory of the gliding of liquids on solid surfaces. D. M. TOLSTOĬ. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 5, 1089–92 (1952) *In Russian.*

In accordance with Frenkel's theory (1945), the following expressions have been derived for the boundary molecules of a liquid: $u_{lim}/u = \exp[(W - W_{lim})/kT] = \exp[\alpha S(K - A)/kT] = \exp[\alpha S\sigma(1 - \cos\theta)/kT]$, where u and u_{lim} are the mobilities, and W and W_{lim} the energies of activation of the molecular motion, in the bulk and on the boundary of the liquid, respectively; α is the fraction of the surface of the molecular micro-cavity, in contact with the surface of the solid boundary; $S = \pi\delta^2_{eff}$ is the effective area of the micro-cavity; K and A, the work of cohesion and adhesion, respectively; σ is the surface tension (liquid/vacuum), and θ is the contact angle. The magnitude u_{lim}/u is related to the phenomenological coefficient of gliding ε (the depth of the fictitious spreading of the flow beyond the boundaries of the solid wall, equivalent to gliding) thus: $u_{lim}/u = \varepsilon/\delta + 1$, hence $\varepsilon = \delta(u_{lim}/u - 1)$, where δ is the average molecular distance. Formulae referred to above can be used for calculating the effect of the gliding near the walls on the discharge per second of a liquid in a circular-section capillary tube. The expression $(Q - Q_0)/Q_0 = (4\delta/r)(u_{lim}/u - 1)$ is obtained, where Q and Q_0 is the discharge with, and without, gliding, respectively. For a cubic micro-cavity, $\alpha = \frac{1}{6}$. If we assume (for Hg on glass at 20°c) $\alpha = \frac{1}{6}$, $\delta_{eff} = 3{\cdot}00$ Å, $\sigma = 490$, and $\theta = 140°$, we obtain that the volume effect of gliding becomes 100% when $r \simeq 30\,\mu$. If, according to Schumacher, we take $\theta = 90°$, the 100% effect is attained at $r \simeq 0{\cdot}4\,\mu$. F. LACHMAN

532.7

3172. Gliding of mercury on glass. D. M. TOLSTOĬ. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 6, 1329–32 (1952) *In Russian.*

See preceding abstract. An apparatus is illustrated and described for determining the effect of gliding on the volume discharge of mercury in glass capillaries with an effective radius of $\sim 3 - 15\,\mu$. Results of measurements show that the relationship between the pressure (excluding the capillary pressure) and the velocity with which the meniscus rises is a linear one ($P = av + b$, where a and b are constants) for Hg, C_6H_6 and H_2O. The magnitude α has been calculated to be 1/9·1 instead of the theoretical $\frac{1}{6}$ for Hg but, if θ is assumed to be 90° (Schumacher), it becomes 1/5·2. F. LACHMAN

532.7

3173. Molal volumes and compressibilities of the system NaCl–H_2O above the critical temperature of water. S. W. BENSON, C. S. COPELAND AND D. PEARSON. *J. chem. Phys.*, **21**, 2208–12 (*Dec.*, 1953).

From quantitative P, T, V, x data on the system NaCl–H_2O in the supercritical region it has been possible to calculate apparent molal volumes, partial molal volumes and compressibilities with accuracies of about 10%, 25% and 15%, respectively. The apparent molal and partial molal volumes of NaCl show similar, remarkable and quite anomalous behaviour. Above the critical temperature of the particular solution studied and at low NaCl compositions, the molal volumes are very large and negative, being of the order of magnitude of litres/mole. As the densities decrease, the values become more negative, pass through a minimum, and then rise again. These minima decrease in absolute magnitude with increasing temperature, but seem to occur (for 0·2% solutions) at densities not very different from the critical density of water. When the partial molal volumes at constant temperature are plotted against partial densities of water, the results seem to fall on a smooth curve independent of the concentration of NaCl. The compressibilities show a behaviour which resembles that of the pure solvent and whose significance has heretofore escaped any detailed attention. They go through maxima at densities near the density at the critical temperature. These observations can be accounted for qualitatively if it is assumed that above the critical temperature all fluids are capable of undergoing continuous, short-range condensation over a narrow range of densities near the critical density of the fluid. The particular behaviour of the

$NaCl–H_2O$ systems emphasizes quantitatively the enormous effect of small amounts of solutes (capable of associating strongly with the solvent) on the behaviour of the solvent near its critical temperature. A.

532.72

3174. On non-stationary diffusion in stratified media. E. Deeg. *Z. angew. Phys.*, **5**, *No.* 10, 370–4 (1953) *In German.*

This problem is solved for a sandwich 1–2–1 formed by two different media 1, 2 of thicknesses d_1, d_2 and diffusion coefficients D_1, D_2 which have, for $t \neq 0$, a constant concentration ratio C_1/C_2 at the two boundaries. It was suggested as a mathematical treatment of the process of drying ceramic suspensions in plaster moulds. H. LONDON

532.73

3175. On Mayer's theory of dilute ionic solutions. E. Haga. *J. Phys. Soc. Japan*, **8**, 714–23 (*Nov.–Dec.*, 1953).

Explicit expressions for the logarithms of the activity coefficient of dilute ionic solutions up to $c^{3/2}$ and for the osmotic pressure up to $c^{5/2}$ are calculated according to Mayer's theory by the use of Fourier transformation. The two prototypes which Mayer supposed, by his rough evaluations, to lead to the terms of higher order are proved to be included in the present approximation. The results of calculations are compared with the existing theories. Calculated osmotic coefficients for 1–1 electrolytes are compared with experimental values, yielding to mean ionic diameters values which are more reasonable than in Debye–Huckel's theory. A.

532.74 : 539.185

3176. Scattering of slow neutrons by protons of dissociated electrolytes. J. Janik. *Bull. internat. Acad. Polon. Sci. A*, *No.* 7–10, 303–5 (*July–Dec.*, 1951).

The slow neutron scattering cross-section of bound protons is greater than that of free protons. This fact is used to estimate the degree of dissociation of H_2SO_4 solutions of varying strength. There is some evidence for the formation of hydrated molecules. J. M. CASSELS

532.77

3177. The lowering of the freezing point in the theory of dipolar coupling. A. Piekara. *Acta phys. Polon.*, **11**, *No.* 2, 99–108 (1952).

The theory of dipolar coupling developed by the author [Abstr. 7835 (1951)] is applied to the calculation of the lowering of the freezing-point of dilute solutions of polar substances in non-polar solvents. The lowering of the freezing-point in these solutions (ΔT) is less than that in "ideal" solutions (ΔT_{id}) in which the dissolved molecules do not exert any forces on each other. The quantity $j = (\Delta T - \Delta T_{id})/\Delta T_{id}$ is calculated on the assumption of a "coupling of the second kind" tending to associate the dissolved molecules in antiparallel couples. The value of $(dj/dm)_{m=0}$, where m is the molar concentration, determines the tangent to the curve $j(m)$ at $m = 0$; it is found to depend on the shortest possible distance r_0 between the molecules. The theoretically calculated tangents fit well enough with the experimental curves. It is emphasized that for nitrobenzene, orthonitrophenol and paranitrophenol no new constants have been introduced, as the value of r_0 was taken from the earlier paper, where it was determined from a discussion of the dielectric, electro-optical and magneto-optical phenomena in solutions of nitrobenzene in non-polar solvents. A.

532.77

3178. Applications of the free volume theory of binary mixtures. Z. W. Salsburg and J. G. Kirkwood. *J. chem. Phys.*, **21**, 2169–77 (*Dec.*, 1953).

Detailed calculations for the free volume theory of binary mixtures are presented and compared with experimental results. It is found that this theory predicts heats of mixing and volumes of mixing larger in magnitude than the observed values and excess entropies of mixing which are smaller than the experimental results. The theory, however, does predict a volume contraction, a negative excess entropy of mixing and a positive heat of mixing for solutions of carbon tetrachloride and neopentane in qualitative agreement with recent observations. A.

532.782

3179. The nonsteady rate of nucleation of a new phase under great supercooling. B. Ya. Lyubov. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 2, 245–8 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-*109.

A non-stationary, initial solution is found for the Smoluchowski-type "diffusion" equation of phase nucleation. It is assumed that (*a*) supercooling is great enough for the thermodynamic barrier term to be neglected; (*b*) the relation $D = kTB$ remains valid when the "mobility" (B) is a function of the "co-ordinate." The result is a nucleation rate proportional to $t^{3/4}$, which may well explain the existence of an incubation period. R. O. DAVIES

532.783

3180. An electrical effect in liquid crystalline solutions containing amphiphilic salts. P. A. Winsor. Letter in *Nature* [*London*] **173**, 81 (*Jan.* 9, 1953).

A turbidity appears in concentrated aqueous solutions of various long-chain electrolytes (e.g. 20 wt.% of tetradecane-7-sodium sulphate) known to be in the liquid crystalline state, when a d.c. potential is applied to them of the order of 30 volts/cm. It disappears rapidly when current is switched off. The effect may be caused by a partial orientation of long-chain ions in the direction of the field, coupled with the difference in refractive indices along and across paraffin chains. R. C. MURRAY

MECHANICS OF GASES 533

533.15

3181. Diffusion and thermal diffusion of isotopic gases. E. M. Holleran. *J. chem. Phys.*, **21**, 2184–7 (*Dec.*, 1953).

The thermal diffusion ratio, R_T, for argon and neon isotopes is known to be a linear function of $\ln T$ over a considerable temperature range. It is shown

that $d \ln D/d \ln T$ must also be approximately linear in $\ln T$, and that the diffusion coefficient, D, should therefore obey an empirical equation of the form $D = \alpha T^{(\beta+\gamma \ln T)}$, where α, β, γ are constants. Considerable latitude is possible in the values of these constants which can reproduce the diffusion data available at the present time. Satisfactory values of β and γ can be found from thermal diffusion data. Except for the factor α, $D(T)$ can thus be calculated from $R_T(T)$. It is also possible to calculate the thermal diffusion ratio as a function of temperature from measurements of the diffusion coefficient, but completely reliable results require more extensive diffusion data than is now available. A.

533.15 : 539.13

3182. The self-diffusion of N_2 and CO_2 at high pressure. On the additivity of intermolecular forces. E. W. Becker, W. Vogell and F. Zigan. *Z. Naturforsch.*, **8a**, 686–94 (*Nov.*, 1953) *In German.*

The pressure-dependence of self-diffusion for N_2 in the range 20 to 90 atm., and for CO_2 from 15 to 52 atm. is investigated at 20°C with isotopes N^{15} and C^{13}. For N_2 the product of diffusion coefficient and gas density is found to be pressure-independent, while for CO_2 it increases by 30% for increasing pressure. It is concluded that the intermolecular forces are additive for N_2, while for CO_2 they lead to association. A description and a diagram of the apparatus are given. F. ANSBACHER

533.15 : 539.13

3183. The temperature dependence of the mutual diffusion coefficient for four gaseous systems. R. A. Strehlow. *J. chem. Phys.*, **21**, 2101–6 (*Dec.*, 1953).

Diffusion coefficients were measured for the systems He–A, H_2–A, H_2–nC_4H_{10}, and H_2–SF_6 over the temperature range 13°C to 150°C. The values were determined by a point concentration analysis, while diffusion proceeded at one end of a Loschmidt-type cell. The analysis was made with a hot-wire technique and utilized the large difference in thermal conductivity to indicate concentration. The generalized equations for calculating D from an experiment with a Loschmidt-type cell are given as well as an analysis of the errors involved in calculating D from these data. The data were used to calculate binary force constants for the Lennard–Jones 6–12 potential. In the system SF_6–H_2 these are $\varepsilon/k = 320°K$ and $(r_0)_{12} = 3{\cdot}25$ Å. The other three systems fit the theory very poorly. The middle temperature value was about 5% low relative to the theoretical curve through the high and low data point. The difficulties of calculating Lennard–Jones force constants from experimental viscosity or diffusion data are discussed. A.

533.16 : 536.48

3184. Measurements of the viscosity of He-gas at liquid helium temperatures as a function of temperature and pressure. A. van Itterbeek, F. W. Schapink, G. J. van den Berg and H. J. M. van Beek. *Physica*, **19**, 1158–62 (*Dec.*, 1953).

Three different types of apparatus based on the oscillating disk method were used. The experimental values obtained for the viscosity coefficient as a function of temperature are approximately 10% too high as compared with the theoretical values calculated by De Boer (1943). The rate of change in the viscosity as a function of pressure agrees very well with the rate of variation found by Ubbink (1947) for the heat conductivity. A.

533.5

3185. Wide-range vacuum gage. C. B. Sibley and J. R. Roehrig. *Electronics*, **26**, 176–7 (*Nov.*, 1953).

Covers range 10^{-4}–10^3 mm Hg in six linear ranges and is an extension of the Downing gauge previously described [G. L. Meller, *Electronics*, **19**, 142–6 (*April*, 1946)]. The output signal is produced by the collection of ions formed by a constant flux of α-particles from a radium source. Two collecting ionizing chambers are used depending on range, the ion current amplified by a factor of 10^7 and indicated on meter and recorder. Contamination of electrodes is negligible as low-voltage collecting field is used. Non-linearity limiting the use of previous gauges has been excluded without sacrificing inherent advantages. Data is given on the sensing element, the Roberts d.c. amplifier and the complete circuit.

E. D. HART

533.5 : 537.534

Vacuum seals for continuously evacuated accelerator tubes operating in high ambient pressures. *See Abstr.* 3552.

533.5 : 537.534

Vacuum system of the cosmotron. *See Abstr.* 3571–2

533.5 : 679.5

3186. High vacuum applications of polythene. J. F. Duncan and D. T. Warren. *Brit. J. appl. Phys.*, **5**, 66–9 (*Feb.*, 1954).

The fabrication of polyethylene vessels, valves, taps, fine control valves, manometers, etc., is described, together with the use of polyethylene in jointing glass, metal, alumina and other ceramics to high vacuum lines. A.

533.6 : 523.161

The motion of a gas cloud expanding into a vacuum. *See Abstr.* 3028.

533.6.011.311 : 532.517

Boundary layer flow near a cylindrical obstacle in an oscillating incompressible fluid. *See Abstr.* 3163

533.6.011.5 : 534.222.2

3187. An approximate study on the detached shock wave in front of a circular cylinder and a sphere. K. Hida. *J. Phys. Soc. Japan*, **8**, 740–5 (*Nov.–Dec.*, 1953).

Assuming the flow behind the detached shock wave to be similar to the rotational flow of an incompressible fluid, various quantities can be determined relating to the shock in such a way that the shock conditions may be satisfied in the neighbourhood of the nose of the shock wave. It is found that the vorticity correction does not alter the non-dimensional curvature of the shock at the nose but makes its location further away from the body than in the case without vorticity. The result is compared with experiment and a fairly good agreement found. A.

533.6.013.22 : 534.232

3188. On sound generated aerodynamically. II. Turbulence as a source of sound. M. J. LIGHTHILL. *Proc. Roy. Soc. A*, **222**, 1–32 (*Feb.* 23, 1954).

For Pt 1, see Abstr. 3372 (1952). The theory of sound generated aerodynamically is extended by taking into account the statistical properties of turbulent airflows, from which the sound radiated (without the help of solid boundaries) is called aerodynamic noise. The theory is developed with special reference to the noise of jets, for which a detailed comparison with experiment is made. The quadrupole distribution of Pt I is shown to behave as if it were concentrated into independent point quadrupoles, one in each "average eddy volume". The sound field of each of these is distorted, in favour of downstream emission, by the general downstream motion of the eddy, in accordance with the quadrupole convection theory of Pt I. Although turbulence without any mean flow has an acoustic power output, which was calculated to a rough approximation from the expressions of Pt I by Proudman [Abstr. 7109 (1952)], nevertheless, turbulence of given intensity can generate more sound in the presence of a large mean shear. This sound has a directional maximum at 45° (or slightly less, due to the quadrupole convection effect) to the shear layer. However, the good agreement, as regards total acoustic power output, with the dimensional considerations of Pt I, is partly fortuitous. The quadrupole convection effect should produce an increase in the dependence of acoustic power on the jet velocity above the predicted U^8 law. The experiments show that (largely cancelling this) some other dependence on velocity is present, tending to reduce the intensity, at the stations where the convection effect would be absent, below the U^8 law. A consideration of whether the terms other than momentum flux in the quadrupole strength density might become important in heated jets indicates that they should hardly ever be dominant. A.

MOLECULAR THEORY OF GASES 533.7

533.7

3189. Temperature jump and velocity of slip at the boundary of a gas. H. PAYNE. *J. chem. Phys.*, **21**, 2127–31 (*Dec.*, 1953).

Approximate expressions are derived from the kinetic theory for the temperature jump and the velocity of slip occurring at an infinite plane solid surface of constant temperature bounding a gas whose state remains invariant throughout all planes parallel to the surface. These derivations differ from earlier ones in the elimination of an assumption, for which an argument is presented as to its untenability, regarding the distribution of the velocities of the molecules striking the surface. Instead, from the mathematical theory of non-uniform gases are derived conditions on this distribution sufficient to confine possible values of the temperature jump and slip velocity to within fairly close limits. A.

533.7

3190. Negative cluster concentrations and association constants. H. WINSTON. Letter in *J. chem. Phys.*, **21**, 2245–6 (*Dec.*, 1953).

Negative values of m_l in the Mayer theory do have a physical significance since the actual number of l-clusters is $m_l +$ (the number which would be formed by random aggregation of clusters with less than l molecules). R. O. DAVIES

533.7 : 539.181

3191. The exchange efficiencies of the translational and the internal energy of gas molecules on solid surfaces. I. Measurement by means of molecular beams. N. SASAKI, K. TAKU AND K. MITANI. *Mem. Coll. Sci. Univ. Kyoto A*, **25**, 75–8 (*Oct.*, 1949).

Describes an apparatus enabling the accommodation coefficients for the translational and internal energy to be determined. A number of horizontal molecular beams (molecular weight m) impinge at a temperature T_0 on a metallic ribbon stretched vertically on a vertical torsion balance and capable of being heated by current induced from outside. If θ_1 and θ_2 are torques when the ribbon temperatures are T_0 and T_1, respectively, then the accommodation coefficient for the translational energy

$$a_t = \left\{\left[\left(\frac{a}{b}+1\right)\frac{\theta_2}{\theta_1} - \frac{a}{b}\right]^2 - 1\right\}\frac{T_0}{T_1 - T_0}$$

where a and b are the correction factors for oblique collisions for ribbon temperatures T_0 and T_1, respectively. The value of a_i (accommodation coefficient for the internal energy) is obtained from the total loss of heat per sec. (E) from the same ribbon, using the formula

$$\frac{17{\cdot}141\ ME(pA)^{-1}\sqrt{T_0} - 3{\cdot}9738\ a_t(T_1 - T_0)}{(H_1 - H_0) - 2{\cdot}9804(T_1 - T_0)}$$

where M = molecular weight, p = pressure (mm Hg), A = surface area of the ribbon in cm^2, H_0 and H_1 are heat contents of the gas at T_0 and T_1, respectively. The values obtained for N_2 at 31·3°C and a Ni ribbon at 518·0°C are: $a_t = 0{\cdot}393$ and $a_i = 0{\cdot}314$. F. LACHMAN

533.7 : 539.181

3192. The exchange efficiencies of the translational and the internal energy of gas molecules on solid surfaces. II. Measurement by means of a vibrating hot filament. N. SASAKI AND K. MITANI. *Mem. Coll. Sci. Univ. Kyoto A*, **25**, 79–81 (*Oct.*, 1949).

Describes a method of determining the accommodation coefficients of gases by measuring the half-decrement period for a Λ-shaped filament vibrating in the given gas, and develops a formula for calculating a_t by the method of successive approximations. The result obtained is $a_t = 0{\cdot}48$ for a W filament at 300°C and H_2 at 23°C. The value of a_i (from total heat loss) = 0·10. F. LACHMAN

533.7 : 541.24

3193. Direct determination of molecular weights of gases and vapours in the pressure range 10^{-2}–10^{-6} mm Hg. H. KOLLMANNSPERGER. *Z. angew. Phys.*, **5**, *No.* 11, 416–21 (1953) *In German.*

Describes a method for a rapid (30 sec) and fairly accurate (error of ±3%) determination of molecular weights of substances in the gaseous state in the pressure range 10^{-2}–10^{-6} mm Hg, and describes and

illustrates the apparatus used for this purpose, in which a rotating cylinder with baffle plates arranged at an angle to the radial direction is subjected to 2 moments of rotation, due to thermal impact and gas friction. By compensating the former moment by the latter, it has been possible to read off molecular weights of gases between 28 and 345 on an indicating revolution counter, the measurements being independent of pressure. In a constant-speed variant, the molecular weight is read off directly as a light-spot on a scale. The apparatus can also be used as a thermal and mechanical manometer within the range referred to above. Results of comparative measurements made with this manometer and the MacLeod gauge are discussed. F. LACHMAN

533.73

3194. Remarks on the classical derivation of Maxwell's law. YU. V. LINNIK. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 6, 1251–4 (1952) *In Russian.*

The particular physical hypothesis that the projections of the velocity of a molecule on any three orthogonal axes are statistically independent is shown to be unnecessary. The number of physical hypotheses required for the derivation of Maxwell's law of velocity distribution can be reduced to a minimum if the derivation is based primarily on purely mathematical facts. F. LACHMANN

VIBRATIONS . ACOUSTICS 534

534

3195. Principles of modern acoustics. G. W. SWENSON, JR. *New York: D. van Nostrand* (1953) 222 *pp.*

Review in *Acustica*, **3**, *No.* 4, 248 (1953).

534.11 : 536.72

3196. Thermal energy in almost-normal modes. J. E. RHODES, JR. *Phys. Rev.*, **93**, 1–3 (*Jan.* 1, 1954).

A mode of motion that consists of a standing wave is usually assigned the thermal energy of a Planck oscillator in thermal equilibrium at the temperature of the medium carrying the standing wave. For a real standing wave which will be damped in time if it is excited beyond the thermal level, the energy of a Planck oscillator E_{p0} is not necessarily the correct energy to assign this mode at thermal equilibrium. For a one-dimensional standing wave where a characteristic impedance for the medium $Z_0 = R_0 + iX_0$ exists, the correct thermal energy (average stored thermal energy) to assign a standing wave E_{sw} is related to the energy of a Planck oscillator by: $E_{p0}/E_{sw} = 1 + X_0^2/R_0^2$. A.

534.121.3 : 534.4

3197. Definitions for the testing of bells. E. THIENHAUS. *Akust. Beihefte, No.* 4, *AB* 251–*AB* 253 (1952) *In German.*

The paper deals with the nomenclature used by bell experts, theologians, church musicians and physicists in describing the characteristics of bells. Among the various factors considered are partial tones, tone intervals, excitation point, striking tone, harmony (internal), damping decrement and reverberation time, partial tone amplitude, sound spectrum and resonance. A three-dimensional diagram is given illustrating the sound-spectrum of a bell in terms of (1) amplitude in %, (2) frequency in cents, and (3) damping in *db*/sec for all the partial tones. Another diagram shows the positions of the nodal lines for these tones. A. B. WOOD

534.141.4

3198. A vortex whistle. B. VONNEGUT. *J. Acoust. Soc. Amer.*, **26**, 18–20 (*Jan.*, 1954).

Simple whistles have been constructed that produce sound by the escape of a vortex from the open end of a tube. The whistle operates equally well on either air or water. When the frequency that is produced by the passage of either air or water is plotted against the volume rate of fluid flow, it is found that the frequency depends almost linearly on the rate of flow and that the number of cycles produced by the flow of a unit volume of air is nearly the same as that produced by the flow of a unit volume of water. Measurements have been made relating the frequency of the sound produced to different pressures of air applied to the whistle. A.

534.141.4

3199. A jet-tone orifice number for orifices of small thickness-diameter ratio. A. B. C. ANDERSON. *J. Acoust. Soc. Amer.*, **26**, 21–5 (*Jan.*, 1954).

The dependence of a jet-tone orifice number $tf/(\Delta p/\rho)^{\frac{1}{2}}$ on Reynolds number $[pt(\Delta p/\rho)^{\frac{1}{2}}]/\mu$ is shown for thin sharp-edged circular orifices whose thickness and diameter both vary from approximately $\frac{1}{8}$ to $\frac{3}{8}$ in., where t is thickness of orifice plate; f, frequency; Δp, pressure difference across orifice; ρ density; and μ, viscosity of gas. Each jet-tone, in general, is composed of harmonics (fundamental and over-tones) as well as subharmonics (tones whose frequencies are less than the fundamental). The subharmonics are relatively unsteady in amplitude compared to the harmonics and may at times have a greater amplitude. The jet-tones at low Reynolds numbers appear relatively free of noise background. In general, as Reynolds number is increased to high values the noise background at first engulfs the subharmonics, then the harmonics. The fundamental is the last to remain, finally disappearing in the noise background. A.

534.21

3200. Relations between the propagation of longitudinal and transverse waves in relaxation media. I. W. KUHN AND S. VIELHAUER. *Z. phys. Chem.*, **202**, 124–60 (*July*, 1953) *In German.*

A theoretical treatment is given of the velocity of propagation and absorption of longitudinal and transverse waves in an amorphous medium which changes from a vitreous solid state to a liquid state as the temperature is raised. Several cases are worked out on the basis of different assumptions regarding the relaxation processes. The bearing of these results on the nature of the earth's core are briefly discussed. H. J. H. STARKS

534.21

3201. Relations between the propagation of longitudinal and transverse waves in relaxation media. II. W. KUHN AND S. VIELHAUER. *Z. phys. Chem.*, **202**, 161–90 (*Oct.*, 1953) *In German.*

The velocities of longitudinal and transverse waves

were measured in a resin at a range of temperatures passing through the softening point. A reduction in the longitudinal velocity at the softening point is explained by the relaxation of the shear stresses, associated with a 30% relaxation in the compressibility modulus. These observations are applied to a consideration of the properties of seismic waves in the earth's interior, with special reference to the discontinuity in the velocity of propagation at a depth of 2900 km, and of the properties of the earth's core.

H. J. H. STARKS

534.21

3202. Wave propagation in a randomly inhomogeneous medium. II. D. MINTZER. *J. Acoust. Soc. Amer.*, **25**, 1107–11 (*Nov.*, 1953).

For Pt I, see Abstr. 154 (1954). The region of validity of the single-scattering approximation used in Pt I is found by considering the next higher approximation; it is valid for $k_0^2 a r \alpha^2 \ll 1$, where k_0 is the wave number of the incident sound, r is the range from source to observer, a is the mean size of the inhomogeneities, and α is the r.m.s. value of the refractive index variations. Some approximate results are given for the case of wavelength large compared with inhomogeneity size. By consideration of the intensity variations, it is found that ray theory is valid for $(k_0 a^2/r) \gg 1$, as has been found for plane waves. A.

534.21

3203. Combined translational and relaxational dispersion of sound in gases. M. GREENSPAN. *J. Acoust. Soc. Amer.*, **26**, 70–3 (*Jan.*, 1954).

It is shown that for a special value of the Prandtl number the Stokes–Kirchhoff equation governing the propagation of sound in a fluid is factorizable even for complex values of the heat conductivity and specific heats. A solution allowing for the dispersion due to both translational and thermal relaxation is thus obtained in simple form for this special case which, however, is representative of many gases with considerable accuracy. A.

534.21 : 532.527

3204. Dispersion of sound in turbulent flow. V. A. KRASILNIKOV AND V. I. TATARSKIĬ. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 2, 159–62 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-121.*

On the assumptions (1) that a turbulent flow can be described by the equations of motion of an incompressible viscous fluid, (2) that in an incompressible fluid, the dispersions by temperature irregularities and velocity fluctuations respectively, are independent, and (3) that the fluctuations of the velocity of flow, v, are considerably smaller than the speed of sound, c, in the medium, it is shown that the wave equation of sound in the moving medium, neglecting acceleration, can be reduced to $\Delta\psi - \partial^2\psi/c^2\partial t^2 = 2v\partial^2\psi/c^2\partial x_i\partial t$, where ψ is the potential function of the sound field. This equation is solved by the method of successive approximations. Expressions are derived for the effective range of sound dispersion in the solid angle $d\Omega$ per unit of distance travelled by the incident sound wave, and for the dispersion coefficient. The coefficient of "backward dispersion" is constant at high frequencies. It is possible that the dispersion of sound by the acceleration field may afford a better explanation of the damping of infra-sonic sound waves in the atmosphere than that afforded by the present theory of dispersion due to viscosity and thermal conductivity.

J. S. G. THOMAS

534.21 : 533.16 : 536.23

3205. The effects of viscosity and heat conductivity on the transmission of plane sound pulses. J. R. KNUDSEN. *J. Acoust. Soc. Amer.*, **26**, 51–7 (*Jan.*, 1954).

The dissipative effects of viscosity and heat conductivity are studied here in connection with the flow of a compressible fluid in a parallel channel or tube. Two kinds of waves or pulses are considered and the distortion from the customary square wave calculated. An observer at a fixed point on the channel and two travelling with the wave are seen to give information as to the order of decay or dissipation of the wave with increasing time. A.

534.21 : 533.16 : 536.23

3206. Decay of spherical sound pulses due to viscosity and heat conduction. J. B. KELLER. *J. Acoust. Soc. Amer.*, **26**, 58 (*Jan.*, 1954).

By combining the results of Kirchhoff and Knudsen (preceding abstract), the effect of viscosity and heat conduction on a spherical sound pulse are found. A rectangular pulse becomes Gaussian, its peak moves with sound speed, its width increases proportionally to $\sqrt{t}$, and its amplitude decreases proportionally to $x^{-\frac{3}{2}}$, where x denotes radial distance from the origin. This behaviour is exactly the same as that of a pulse in one dimension, except for an extra factor of $1/x$ which accounts for the spherical spreading. A.

534.22

3207. Dispersion of the velocity of ultrasound in superheated *n*-hexane vapours. V. F. NOZDREV. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 5, 1005–7 (1952) *In Russian.*

The velocities of ultra-sound have been determined by an optical method (described elsewhere) for temperatures between 180–330°c, pressures 2–26 atm., and frequencies 450–3050 kc/s; no dispersion has been observed down to $P = 8$ atm. Beginning with ~ 210°c, the velocities for $P = 5{\cdot}5$ atm. and $\nu = 1950$ kc/s and for $P = 8$ atm. and $\nu = 2800$ kc/s (in either case ν/P being $= \sim 350$ kc/s/P) coincide. The dispersion phenomenon has been confirmed by the results of measurements at $\rho = \text{const.}$

F. LACHMAN

534.222.2

3208. Temperatures attained by the meeting of detonation waves. S. TRAVERS. *C.R. Acad. Sci. [Paris]* **237**, 1492–3 (*Dec.* 9, 1953) *In French.*

While very high temperatures are attainable by the normal collision of shock waves in a neutral medium, e.g. 30 000°K in argon, it is shown, by application of the classical Rankine–Hugoniot adiabatic shock equation, that temperatures attainable by the direct collision of detonation waves at a temperature of 5000°K are unlikely to exceed 6000°K. It is suggested that to exceed 10 000°K the impact of explosive waves should occur in a rarefied atmosphere in which the velocity of expansion of the products of explosion can

exceed the limiting velocity of permanent flow of the products. J. S. G. THOMAS

534.222.2

3209. A method for generating strong shock waves. A. HERTZBERG AND W. E. SMITH. Letter in *J. appl. Phys.*, **25**, 130–1 (*Jan.*, 1954).

A simple modification of the operation of the combustion-powered, high-pressure-ratio, shock tube, permitting extension of its range, is discussed. The essential point is that the diaphragm separating the high-pressure chamber from the low-pressure chamber in the shock tube is pierced mechanically immediately following ignition of the combustible mixture.

J. S. G. THOMAS

534.222.2

3210. On gas flow in one dimension following a normal shock of variable strength. C. W. JONES. *Proc. Roy. Soc. A*, **221**, 257–67 (*Jan.* 21, 1954).

Unsteady non-homentropic flow of a gas in one dimension is studied by taking a form of the Lagrangian equations of motion. An "exact" solution representing progressive waves is found, and this is applied to the problem of a shock advancing into a region in which the pressure is constant, but the density (and temperature) varies according to a simple power law. The problem is shown to depend upon a single first-order differential equation of standard type, and it is indicated how numerical solutions could be constructed if desired. For convenience in presentation, however, the discussion is limited to the case of a very strong shock, and only qualitative conclusions are offered at this stage. A.

534.222.2 : 534.37

3211. Attenuation of repeated shock waves in tubes. G. C. WERTH AND L. P. DELSASSO. *J. Acoust. Soc. Amer.*, **26**, 59–64 (*Jan.*, 1954).

As very intense sound waves propagate, the wave-shape changes into one of saw-tooth form producing abrupt rises in pressure called shock fronts. This waveform distortion into so-called repeated shock waves is caused by the nonlinearity of the medium. The objective of this study has been to obtain experimental facts relative to the propagation of repeated shock waves in tubes and to compare these with existing theory. An intense sound source was constructed and appropriately coupled to a series of measuring tubes. Observations were made on the velocity and attenuation of fully developed shock waves for a variety of gases, for pressure amplitudes as great as 0·25 atm., and for a fundamental frequency range of from 400 to 1200 c/s. The data were compared with previous theoretical work, particularly that of Rudnick. Agreement was found in the general aspects of the theory; the exact magnitude of the effect remains to be explained. This discrepancy between theory and experiment may be resolved by considering in greater detail the absorptive processes involved. A.

534.23

3212. Transmission of sound through a stretched membrane. U. INGARD. Letter in *J. Acoust. Soc. Amer.*, **26**, 99–101 (*Jan.*, 1954).

The problem of sound transmission through a membrane stretched across a duct is analysed rigorously. The integral equation for the velocity distribution of the membrane is set up and studied in the special case of a circular cylindrical tube. Equivalent circuits for the membrane are shown for the frequencies around the resonances and the anti-resonances of the membrane. High transmission loss is commonly associated with a large mass, but it is clear that it can also be obtained with very little mass if stiffness rather than mass provides the high impedance. A.

534.23

3213. The frequency dependence of ultrasound intensity. S. PARTHASARATHY, D. SRINIVASAN AND S. S. CHARI. *Z. Phys.*, **136**, *No.* 1, 17–20 (1953) *In German.*

For normal liquids the authors have found [Abstr. 5921 (1953)] that at frequencies of 5 Mc/s and below the intensity I_0 is proportional to α/ν^2, though at higher frequencies it is not so. This has prompted the present investigation of the frequency dependence of the intensity of ultrasound emitted from a quartz crystal excited at constant potential. The intensity does decrease with frequency, but whether sufficiently to alter the previous conclusions is not discussed. T. C. TOYE

534.23

3214. Resonance absorption of sound in paramagnetics. S. A. AL'TSHULER. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 6, 1235–8 (1952) *In Russian.*

The magnitude of this effect and the possibility of its experimental measurement are analysed theoretically for Ti and Cr alums [cf. J. H. van Vleck, *Phys. Rev.*, **57**, 426–47 (*Mar.* 1, 1940)]. It may be expected that hydrated salts of some rare-earth metals, when observed at the temperature of liquid H, would yield relatively large values for the lattice-relaxation time. This period is of the order of 10^{-2} sec for several alums and a sulphate investigated at the temperature of liquid He; hence the coefficient of sound absorption, i.e. the ratio of energy absorbed per cm^3 to energy incident on 1 cm^2 is of the order of 1 cm^{-1}. It follows that the effect should be observable.

F. LACHMAN

534.23

3215. Absorption of ultrasound in solutions of polymers. YU. YA. GOTLIB AND M. V. VOL'KENSHTEIN. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 5, 821–4 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-116.

An expression is derived for α, the coeff. of absorption of ultrasound in a solution of a polymer, assuming the latter to be a succession of spherical segments each containing 20–40 atoms, joined by quasi-elastic bonds. Values of α calculated from this expression agree with the experimental ones of Mikhaĭlov and Shagalova (following abstract) to within an order of magnitude, which is very satisfactory in view of the assumptions made. R. C. MURRAY

534.23

3216. Propagation of ultrasonic waves in polymer solutions. I. G. MIKHAĬLOV AND L. A. SHAGALOVA. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 5, 829–32 (1952) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-117.

The absorption of ultrasound in solutions of polystyrene in benzene and of oppanol in transformer

oil, expressed as α/ν^2, where α is the coeff. of absorption and ν is the sonic frequency, increases very much less with concentration than would be predicted by calculation from Stokes' formula. The results for oppanol cannot be interpreted in terms of friction of the solvent with immobile polymer molecules: the additional absorption due to the presence of solute, thus calculated, is several times that measured. A formula derived by Gotlib and Vol'kenshtein (preceding abstract), allowing for motion of the clusters of chain molecules within the solvent, gives satisfactory agreement with experiment when applied to solutions of polystyrene in benzene. R. C. MURRAY

534.23

3217. Absorption of ultrasonic waves in some viscous liquids. I. G. MIKHAĬLOV. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 6, 991–3 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-59.*

While measurements of the absorption of ultrasound in cottonseed oil at various frequencies disclose no deviation of the measured values of α/ν^2 (α = coeff. of absorption, ν = frequency) from those predicted by Stokes' formula, there is considerable divergence with castor oil and tung oil, indicating relaxation in the shear viscosity. For tung oil the time of relaxation, τ, is calculated from the results to be $1{\cdot}2\times10^{-8}$ sec, and the relative dispersion to be $\sim 1{\cdot}3\%$; the corresponding figures for castor oil are $2{\cdot}1\times10^{-8}$ sec. and $2{\cdot}9\%$: the τ value for this oil deviates considerably from the $1{\cdot}5\times10^{-7}$ sec for the time of orientational relaxation in it obtained by Tsvetkov and Éskin [Abstr. 134 (1949)]. R. C. MURRAY

534.23

3218. Absorption coefficient of ultrasonics in some liquid determined by the new thermal technique. S. PARTHASARATHY AND P. P. MAHENDROO. Letter in *Nuovo Cimento*, **10**, 1196–7 (*Aug.*, 1953).

In previous papers [Abstr. 5920, 7529, 8284, 8291–2 (1953)] it was shown that the heat generated at any point in the liquid is proportional to the sound intensity at that point. This leads to the relation $H_x = H_0 \exp(-2\alpha x)$ where H_x and H_0 are the values of heat generated at two points on the axis of the sound beam distance x apart. The authors use this for determination of α at a frequency of 5 Mc/s and find agreement with other methods. T. C. TOYE

534.23 : 532.584

3219. Ultrasonic attenuation in biological suspensions. T. F. HUETER, H. MORGAN AND M. S. COHEN. Letter in *J. Acoust. Soc. Amer.*, **25**, 1200–1 (*Nov.*, 1953).

A linear relationship between attenuation and frequency is found over a wide frequency range for both homogenized and skimmed milk. The analogous results found in these two cases are considered to disprove a theory which attributes the attenuation solely to the viscous forces on the spherical fat particles suspended in the viscous liquid (water casein solution). Since the skimmed milk still absorbs appreciably although most of the fat particles have been removed the effect is considered to be due in part to the complex casein molecules T. C. TOYE

534.23 : 534.39

3220. The thermal effect of ultrasonic waves in liquids and its relation to their absorption coefficient. S. PARTHASARATHY, D. SRINIVASAN AND S. S. CHARI. Letter in *Acustica*, **3**, *No.* 6, 407–8 (1953).

Using the method described previously [Abstr. 1675 (1950)] the authors have extended their study and shown that at 5 Mc/s all except anomalously absorbing liquids (C_6H_6 and CS_2) give a constant value for $h/(\alpha/f^2)$ where h is the heat produced per second by the ultrasound of frequency f. This appears therefore to be a good method for determining the absorption coefficient α. T. C. TOYE

534.232

3221. A physical approach to the generalized loudspeaker problem. O. K. MAWARDI. *J. Acoust. Soc. Amer.*, **26**, 1–14 (*Jan.*, 1954).

Most analyses of loudspeaker performances are based primarily on the consideration of details of the electromechanical coupling. This approach has proved too inadequate to handle loudspeaker radiation problems. An attempt has been made to set up a general expression relating the free field sound pressure at a remote point to the electrical signal applied to the loudspeaker terminals. This relation in the form of an integral equation is solved exactly for a loudspeaker of circular shape. By means of the solution of the integral equation it appears possible to apply to this problem methods analogous to circuit analysis techniques which represent the transfer function of the system in terms of its characteristic points in the complex frequency plane. A.

534.232

3222. A linear, passive, nonreciprocal transducer. R. J. BOBBER AND C. L. DARNER. Letter in *J. Acoust. Soc. Amer.*, **26**, 98 (*Jan.*, 1954).

An underwater sound transducer which uses two different types of electromechanical coupling has been built, and its non-reciprocal nature is illustrated with directivity patterns. A.

534.232 : 621.395.62

3223. Derivation of the laws of force for all types of magnetic and electric transducers from a general law for each of the two classes. F. A. FISCHER. *Acustica*, **3**, 441–8 (1953) [= *Akust Beih.*, *No.* 3 (1953)] *In German.*

If the magnetic energy of a system of two coupled coils and the electric energy of two coupled electric leads respectively is calculated, the mechanical force is generally given by the derivative of the energy with respect to the variable co-ordinate, supposing that there exists only one spatial variable. The different types of transducers result from a proper choice of this variable co-ordinate. Some new aspects for the systematology of electroacoustic transducers are obtained by this derivation. A.

534.232 : 621.395.623

3224. Dual-stylus ceramic phonograph pickup development. H. W. KOREN, H. A. PEARSON, H. KLINGENER AND R. W. SABOL. *J. Acoust. Soc. Amer.*, **26**, 15–17 (*Jan.*, 1954).

The freedom from humidity and temperature limitations have made ferroelectric ceramics a valuable type of transducer for gramophone pickups (originally de-

signed for 78 r.p.m. records). Two groove sizes now require the use of dual styli. A pickup structure is described in which dual styli are used back-to-back on one lever. A mechanism is provided on the bottom of the pickup whereby the stylus assembly can be turned over to present the proper stylus to the record. This structure imposes no dynamical limitations on the performance of the pickup, as the additional mass required for the second stylus is only a small percentage of the total mass, and no additional stiffness constraints are imposed on the system. Reasonably flat characteristics have been obtained. In one commercial model a sensitivity of over one-half volt is achieved on microgroove records, with a frequency range to 10 000 c/s with a tracking force of 6 g for microgroove and 9 g for standard groove records. A.

534.24

3225. Reflection from a statistical array of scatterers. J. C. GRACE. Letter in *J. Acoust. Soc. Amer.*, **26**, 103–4 (*Jan.*, 1954).

The average energy spectrum of the reflection from an array of randomly located point scatterers has been calculated. It is shown that this spectrum is proportional to the square of the sum of the individual scatterer amplitudes for wavelengths large compared to the extent of the array and that it is proportional to the sum of squares of the individual amplitudes for wavelengths small compared to the array extent. A.

534.24

3226. The reflexion of sound waves of finite amplitude by a rigid wall. E. T. COPSON. *Proc. Roy. Soc. A*, **222**, 254–61 (*March* 9, 1954).

A polytropic gas of adiabatic exponent $\frac{5}{3}$ fills the half-space on one side of a rigid plane wall of infinite extent. Initially the gas is at rest and its density is proportional to $x^{\frac{3}{2}}$, where x is the distance from the wall. The gas starts moving towards the wall. It is shown that, although the data are continuous, the problem has no continuous solution, that reflection at the wall generates a shock wave. The problem is solved completely without recourse to numerical integration. A.

534.26

3227. Scattering of underwater plane ultrasonic waves by liquid cylindrical obstacles. S. J. BEZUSZKA. *J. Acoust. Soc. Amer.*, **25**, 1090–5 (*Nov.*, 1953).

Reports a theoretical investigation of sound scattering from liquid cylindrical obstacles immersed in water following closely the conditions prevailing in the previous experimental work of Tamarkin [Abstr. 2275 (1950)], Bauer, and others. An incident plane wave being assumed, a series solution was found for the total scattered wave. Numerical calculations were carried out using parameters approximating those of Tamarkin's experiments (radius of obstacle, 0·635 cm; sound frequency, 1·145 Mc/s; wavelength, 0·13 cm). A series of scattering patterns, confined principally to the forward direction for an angular spread of about 14° (with the obstacle at the vertex) were calculated for eight liquids, chosen to give a spread of k_1a values (k_1 the wave parameter inside the liquid and a the radius) between 26·0 and 41·0. The results of this theoretical investigation confirm the experimental findings that for the liquids examined the scattering is diffractive and lies in the zone between the geometrical region and the region of Rayleigh scattering. Quantitative comparisons are made between the theoretical and experimentally plotted results with special emphasis on the experimental resonance curve and its theoretically computed counterpart. A.

534.321.9 : 535.42

Diffraction of light by superposed ultrasonic waves—a theoretical study. *See Abstr.* 3339

534.321.9 : 541.15

3228. Elucidation of the chemical effects of ultrasonics. H. H. RUST. *Angew. Chem.*, **65**, *No.* 10, 249–52 (1953) *In German.*

Results of the author's and other investigators' experimental work confirm the conception that the destructive chemical effect of ultrasonics is due to gas bubbles vibrating in resonance in stationary wave fields. The behaviour of gels and liquids with a high gas content and other phenomena are easily explained by the author's theory. F. LACHMAN

534.372

3229. Thermal damping of elastic vibrations. Comments on a work of the same title by E. Schreuer. M. PÄSLER. *Z. Phys.*, **136**, *No.* 1, 67–73 (1953) *In German.*

Discusses some discrepancies in the formulae for the logarithmic decrement of a vibrating bar obtained by Schreuer [Abstr. 5631 (1952)], and by Zener and the author and claims that the author's expression is correct. H. J. H. STARKS

534.372

3230. On the dissipation of elastic waves in lead at high temperature. P. G. BORDONI AND M. NUOVO. *Nuovo Cimento*, **11**, 127–41 (*Feb.*, 1954) *In Italian.*

For previous work, see Abstr. 8285 (1953). The damping of extensional vibrations has now been measured in the range from 10 to 40 kc/s and for temperatures between 300°K and 600°K with the same electrostatic method. Damping has been evaluated by means of the inverse value of the resonance coefficient Q. It was found that Q^{-1} increases continuously with increasing temperatures, from values of $3 - 5\times10^{-3}$ up to $15 - 20\times10^{-3}$; for a given temperature Q^{-1} decreases with increasing frequency. The explanation of these phenomena is discussed. A.

534.39

3231. The mean force on a sphere in a spherical sound field. I. (Theoretical). T. F. W. EMBLETON. *J. Acoust. Soc. Amer.*, **26**, 40–5 (*Jan.*, 1953).

The mean force acting on a rigid sphere placed in a progressive spherical sound field has been obtained by integration of the individual contributions from the velocity potential and particle velocity acting on each element of the sphere's surface. Motion of the sphere under the action of the first-order pressure variations in the sound field has been taken into account. The radiation force has been expressed as an infinite series of inverse powers of the source distance, each term of which is multiplied by an infinite power series in terms of sphere radius. At very large distances from the source the radiation force obeys an inverse square law of repulsion. As the source of the field is approached, the repulsion decreases to zero and

then becomes a force of attraction. The extent of this region of attraction is determined both by the frequency of the sound field and by the size of the detecting sphere; lower frequencies and smaller spheres both extend the region. Even when allowance is made for an inverse square law, the attractions may be many times greater than the repulsions in the same sound field. A.

534.39

3232. Mean force on a sphere in a spherical sound field. II. (Experimental). T. F. W. EMBLETON. *J. Acoust. Soc. Amer.*, **26**, 46–50 (*Jan.*, 1954).

The theory of Pt I has been verified by a series of quantitative experiments. Several hollow glass spheres (0·228 to 3·029 cm radius) were suspended in turn by a fine glass fibre in the sound field in air; the deflection of each was measured at known frequencies (300 to 7000 c/s) and amplitudes (0 to 1400 d/cm^2) of the sound field. Care was taken to protect the sphere from any gas streaming to or from the source and to insure that the field was accurately spherical. All measurements were made under such conditions that the sound field was substantially sinusoidal. Good agreement was obtained between theory and experiment within the range of the variables investigated. In the region where radiation forces of attraction existed, this agreement was always within a few percent, even though the magnitude of the forces changed by a factor of 100 or even 1000 to 1 in a single experiment. In the region of repulsion measurements could not be made with any great accuracy, but even so the agreement here was within the limits of experimental error. A.

534.512 : 534.321.9

3233. Interaction of ultrasonic waves in liquids. G. D. MIKHAĬLOV. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 4, 663–4 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-70.*

Sum and difference frequencies have been produced by heterodyning wave systems from two separate quartz ultrasound generators, placed at right angles to one another in a liquid. The rate of decay of the amplitude of both frequencies (sum and difference) with distance is the same, confirming Helmholtz's theory that the amplitude of such waves is proportional to the product of the component amplitudes.

R. C. MURRAY

534.6/.7

3234. Technical aspects of sound. Volume I. E. G. RICHARDSON. *Amsterdam: Elsevier Publishing Co.* (1953), 544 *pp.*

Review in *Acoustica*, **3**, *No.* 6, 408 (1953). "The text is divided into six divisions written by experts on the various fields: (1) acoustic measurements and materials; (2) acoustics of buildings; (3) noise; (4) speech and hearing; (5) sound reproduction; (6) analysis and synthesis of sound, design and performance of musical instruments. Volume II, which will be issued in 1954, will cover ultrasonic sound. 719 references."

534.61

3235. The mercury thermometer. An instrument for the measurement of high intensity ultrasonic waves. O. LINDSTRÖM. *Acustica*, **3**, *No.* 3, 199–200 (1953).

An ingenious adaptation of the thermal method of determination of ultrasound intensity. An ordinary mercury-in-glass thermometer is used as the temperature indicator, the bulb being situated in the acoustic fountain, the surface of which is thought to act as a reflector focusing the waves on the bulb and giving a larger temperature difference. A linear relation is shown to exist between power input and temperature difference, showing that the mercury thermometer is a very convenient and useful instrument for this purpose. T. C. TOY

534.612.2 : 621.395.6

3236. Microphones measure high-intensity sound. J. K. HILLIARD. *Electronics*, **26**, 160–3 (*Nov.*, 1953).

In aircraft noise measurement a range of +40 to 220 db (above 0·0002 dynes/cm^2) and a frequency range of 3–30 000 c/s have to be covered. For this work a condenser microphone is always employed although the diaphragm is stiffer than usual and clamped tightly round the edge. Furthermore, while the front surface is laminated with a molecular gold coating, the insulating base material prevents short circuits at the back on overload. The head amplifier consists of a single cathode-follower stage. Such a microphone will stand a temperature of 1600°F for a few seconds: for prolonged exposure to high temperatures a probe tube, briefly described, can be introduced. Piston-phones, cone-type loudspeakers and special microphones are used for calibrating. The piston-phone is described in detail. The intensity and distribution of aircraft noise, particularly of jet engines, is discussed at length and the necessity for monitoring and control at engine factories emphasized. Brief reference is made to deafness hazard and to other high-intensity sources such as drop forges, trip hammers and rocket launching.

H. G. M. SPRATT (R

534.61

3237. Measurement of the velocity of sound in the ocean. R. K. BROWN. *J. Acoust. Soc. Amer.*, **26**, 64–7 (*Jan.*, 1954).

An underwater sound velocity meter, which makes continuous recordings of the velocity of sound in the ocean as a function of depth, is described. A phase comparison system of measurement is employed at 500 kc/s. Several velocity and temperature records are given for comparison. A

534.62

3238. Measurements of the coefficients of absorption of sound, at the cinematography experimental centre of Rome. G. PAROLINI. *Ann. Télécomm.*, **8**, 391–4 (*Dec.*, 1953) *In French.*

Measurements have been made, by the reverberation room method, of the sound absorption coefficients of a large number of different absorbers. The measuring procedure is described and tabulated results are given for different frequencies and different materials. The frequency range extends from 129 to 2069 c/s and the materials vary from wall and floor coverings to period costumes of the Renaissance and the 19th century. A. B. WOOD

534.7 : 612.8

Physiological acoustics. Hearing. *See Abstr.* 406

534.76

3239. Basic principles of stereophonic sound. W. B. SNOW. *J. Soc. Motion Picture Televis. Engrs*, **61**, 567–89 (*Nov.*, 1953).

Summarizes the theory underlying stereophonic sound so far as it is known and gives examples of application of the theory to practical situations. A comparison is made between binaural listening and stereophony. The "ideal" system, using a large number of very small microphones and loudspeakers, is compared with the more practical system in which, say, only three microphones and loudspeakers are used to create the illusion of sounds from a stage or platform having direction and "depth." The effect of varying position of observer in the auditorium is also discussed. The problems particularly associated with recording are shown to be similar but not identical with those of reproduction. A. B. WOOD

534.781

3240. General analysis of the acoustic structure of speech sounds by superposition of the periodic components and the random components. R. HUSSON AND R. SAUMONT. *C.R. Acad. Sci.* [*Paris*] **237**, 1555–6 (*Dec.* 9, 1953) *In French.*

It is pointed out that speech sounds can be analysed into periodic components, characterized by a spectrum of frequencies, and by random components, characterized by a certain amount of auto-correlation. Their physiological origins are different as well as their discriminative powers by the receiving ear. A classification is given relating to different forms of voice production—speech and singing voice (with or without nasal character). A. B. WOOD

534.79

3241. On the theory of volume and loudness. G. QUIETZSCH. *Tech. Hausmitt. Nordwestdtsch. Rdfunks*, **5**, *No.* 9–10, 169–77 (1953) *In German.*

After defining the phon scale (volume scale) a comparison is made of curves of equal volume published by various investigators and the threshold value curves are compared, any important differences being stressed. Since the phon scale does not correspond to the true perception of loudness by the ear a new, purely subjective, "sone" scale (loudness scale) has been developed. An explanation of the sonephon function is attempted and its advantages pointed out. Allied problems are discussed and some recent experimental work is quoted. A. B. WOOD

534.79

3242. A technique and a scale for loudness measurement. W. R. GARNER. *J. Acoust. Soc. Amer.*, **26**, 73–88 (*Jan.*, 1954).

A method of loudness scaling is presented for obtaining a true ratio scale of loudness. Two separate loudness functions are required, one based on equisection judgments and the other based on fractionation judgments. Interrelation of these two scales allows determination of all constants necessary for a ratio scale, The method provides validation of the assumptions underlying its use. Experimental data are also presented which show that (1) the method is valid for individual observers; (2) differences between loudness scales of different observers are considerably reduced with the method; and (3) the loudness function obtained with this method is much flatter than the standard scale now used. It is then shown that this new loudness scale is in better agreement with other data on equal loudness intervals than the standard scale. It is also shown that this scale is in agreement with monaural-binaural loudness data, and data on loudness of multicomponent tones. A.

534.833.4 : 534.62

3243. On the absorption coefficient of acoustic materials. R. LAMORAL. *Onde élect.*, **33**, 461–7 (*July*, 1953) *In French.*

Results are given of measurements made under controlled conditions calculating the coefficients from reverberation experiments and the Sabine formula. The importance of surface area, position of material in the room and the form of construction of the material, are stressed. The work is not yet complete, but the dispersion of the results is used to indicate the importance of controlling these variables in absorption coefficient measurements and also when the materials are used in practice. G. F. HODSMAN

534.843

3244. Comparative measurements of the acoustics of buildings. G. BECKER, G. BOBBERT AND H. BRANDT. *Akust. Beihefte*, *No.* 3, *AB* 176–*AB* 180 (1952). *In German.*

A comparison is made of the characteristic acoustic properties of rooms, in eight German research institutes with their equipment. The tests of the measuring equipment, e.g. the properties of the receivers for sustained tones and for short pulses, and their directional properties at frequencies of 1000 and 3200 c/s are compared. Comparative tests of the receivers from the eight institutes were then made on sound transmission of standard floors and walls, over a frequency range 100 to 4000 c/s. On the whole, the agreement was very good. A. B. WOOD

534.846.6

3245. Acoustic study of large rooms using models. R. LAMORAL AND R. TREMBASKY. *Onde élect.*, **33**, 570–5 (*Oct.*, 1953) *In French.*

In studying the acoustics of a large concert hall it is usual to divide the problem into two parts:—(1) Research on an acceptable geometrical form—this includes the question of fundamental echoes (the "free" echo and the "flutter" echo). In this connection the work of Haas in particular gives the path difference which is acceptable between two acoustic "rays" as a function of their relative density. (2) Calculation of the acoustic coverings (absorbent surfaces) which can be used. The paper deals with an examination of the problem by scale models in which the scale or ratio between the wavelength of the sound employed and the linear geometric dimensions of the room is fixed. Thus the classical frequencies (256, 512, 1024, etc.) full scale are, in a model of 1/30 scale, 7·680, 15·360, 30·720, etc. It is also necessary to create a range of covering materials of absorption coefficients ranging from 0 to 1 for these high frequencies. The directional properties of the sound sources and receivers are also of importance at ultrasonic frequencies—it being necessary to modulate the frequency of the signals to minimize stationary

wave effects. A pulse technique with c.r.o. indication of signal and echoes is described and illustrated by actual records. A. B. WOOD

534.862.3 : 621.395.625.3

3246. Gap-length formula in magnetic recording. W. K. WESTMIJZE. Letter in *Acustica*, **2**, *No.* 6, 292 (1952).

The well-known formula gap-loss = $\sin(\pi d/\lambda)\pi/\lambda$, where d is the slit width and λ the recorded wavelength, while applicable to optical recording, is certainly not correct when applied to magnetic recording. A modified form, loss = $\sin(\pi l/\lambda)/\pi\lambda/\lambda$, due to Lübeck is only approximately correct. A detailed analysis provides a complicated formula which with some reservation can be simplified to loss = $0{\cdot}699 \sin(\pi l/\lambda + \pi/6) \div (\pi l/\lambda)^{2/3}$. This reveals the facts that (*a*) the first zero occurs at $l = 0{\cdot}88\lambda$ and not at $l = \lambda$ so that the effective gap length as usually derived from the wavelength characteristic is in fact 10% too great and (*b*) if the recorded flux is calculated by the "wide-gap method," a correction of 2 db/octave must be applied to obtain results consistent with narrow-gap measurements. H. G. M. SPRATT

534.88 : 531.719.35

3247. Development of acoustic methods of measuring the depth of the sea. H. DRUBBA AND H. H. RUST. *Z. angew. Phys.*, **5**, *No.* 10, 388–400 (1953) *In German.*

The development is dealt with historically and begins with the experiments of Colladon in 1826 to measure the velocity of sound in water using a bell as the source of sound. Bonnycastle in 1838 made the first measurements of the depth of the sea using the echo-sounding technique and bells as the source. Details are given of the development of the various techniques leading up to the modern ultrasonic methods employing piezoelectric and magneto-strictive transducers and automatic recording equipment. The paper contains 104 references to the literature. A. C. WHIFFIN

OPTICS . RADIATION . SPECTRA 535

535.137 : 537.311.62

Theoretical optical properties of thin metallic films. *See Abstr.* 3486

535.14 : 535.23

3248. Coherence in spontaneous radiation processes. R. H. DICKE. *Phys. Rev.*, **93**, 99–110 (*Jan.* 1, 1954).

By considering a radiating gas as a single quantum mechanical system, energy levels corresponding to certain correlations between individual molecules are described. Spontaneous emission of radiation in a transition between two such levels leads to the emission of coherent radiation. The discussion is limited first to a gas of dimension small compared with a wavelength. Spontaneous radiation rates and natural line breadths are calculated. For a gas of large extent the effect of photon recoil momentum on coherence is calculated. The effect of a radiation pulse in exciting "super-radiant" states is discussed. The angular correlation between su cessive photons spontaneously emitted by a g initially in thermal equilibrium is calculated.

535.23.08 : 536.

3249. A photometric method of determining co figuration factors. D. I. LAWSON AND D. HIR *Brit. J. appl. Phys.*, **5**, 72–4 (*Feb.*, 1954).

The configuration factor is a measure of the intensi of radiation falling on a receiver, and depends n only on temperature and distance of the radiator, b also on size and orientation. A photometric analog method is described which enables a speedy explor tion of configuration factors to be made. The meth can also be used to solve the reverse problem finding the positions with respect to a radiator which there is a given configuration factor. Where the method can be applied more easily to tw dimensional sources of radiation, it can also b applied to many three-dimensional radiators.

535.23.08–1

3250. An aromatic detector for the infrared. B. D McMICHAEL, E. A. KMETKO AND S. MROZOWSK *J. Opt. Soc. Amer.*, **44**, 26–30 (*Jan.*, 1954).

It has been shown previously that in order t explain the electronic processes in a whole class o aromatic solids starting from the aromatic molecula systems and running through condensed aromatic baked carbons and polycrystalline graphite to perfe graphite crystals, the existence of an energy ga between the filled π-band and the conduction ban has to be assumed, the energy gap decreasing gradual with the increase of molecular dimensions and di appearing in the limit for large graphite crystal This process of the gradual decrease of the energ gap was later investigated for pyrolysed cellophan films heat-treated up to temperatures of 800°c b study of the position of the long wavelength limit o the absorption. It was found that the position of th absorption limit does in fact move from the visibl into the infrared with increase in molecular siz (increase of maximum heat-treatment temperature The possibility of an exact control in the position o the infrared limit and furthermore the possibility o shifting it as far into the infrared as necessary shoul make such substances of great value as photodetectors In this paper, preliminary results of experiment performed with thin films of condensed aromati substances are reported. The presence of a photo response with a sensitivity limit roughly correspondin to the absorption limit has been established usin square-wave illumination with frequencies up t somewhat more than 2000 c/s. The current show saturation within about one-twentieth of a second The amplitude of the fundamental is given as function of pulse frequency. The signal-to-nois ratio is found to be considerably inferior to tha shown by commercial PbS photocells. The simplicit of such cells is remarkable, however, and might be great asset for some special applications. Cells wit infrared limits of photoresponse up to somewhat mor than 5 μ were obtained, the extension into th farther infrared being prevented by the increase i the conductivity of the films. The photorespons seems to be a complicated process involving a com

ination of a photoelectric excitation with an effect f essentially bolometric nature. A.

535.233 : 536.3

3251. Separation of incident and emitted radiations in a solar furnace by means of rotating sectors. W. M. CONN AND G. BRAUGHT. *J. Opt. Soc. Amer.*, **44**, 5–7 (*Jan.*, 1954).

An image of the sun was formed on a sample by means of a paraboloidal mirror. The sample was heated to a desired temperature adjusting the effective aperture of the mirror. A cylindrical shutter travelling along the optical axis of the mirror was used. The temperature of the sample was measured with an optical pyrometer. Radiation incident on the sample was shut off while measuring its brightness temperature by means of sectors rotating at about 2500 r.p.m. One sector of special shape was located near the sample and another sector near the telescopic system. Calibration and use of the sectors for solar furnaces equipped with mirrors of maximum apertures 50 in. and 120 in. and focal lengths 26 in. and 34 in. are discussed. A.

535.241

3252. Primary standard of luminous intensity at the National Research Council of Canada. C. L. SANDERS, B. A. STEVENS AND W. E. K. MIDDLETON. Letter in *J. Opt. Soc. Amer.*, **44**, 88–9 (*Jan.*, 1954).

The freezing platinum standard was set up at Ottawa and the 12 lamps used in Canada as standards of luminous intensity were compared with it. Both visual and photoelectric comparisons, 84 in all, were made. Since the lamps had been compared with 5 standard lamps from the B.I.P.M. at Sèvres, it was possible to deduce the ratio of the candela as determined in Canada to that adopted internationally. The value found was 1·0042. [There are two misprints in the values given in Table II.] J. W. T. WALSH

535.241.39 : 537.533.9

3253. A standard light source of very low intensity based on the Čerenkov effect. W. ANDERSON AND E. H. BELCHER. *Brit. J. appl. Phys.*, **5**, 53–7 (*Feb.*, 1954).

Standard light sources of very low intensity for use in studies of luminescent effects have been developed using the visible Cherenkov emission from aqueous solutions of β-ray emitting radioactive isotopes. The measured relative intensities of the emission from various β-ray emitters showed agreement with the classical theory of Frank and Tamm for the Cherenkov effect. The absolute intensities observed were not incompatible with the latter theory. Measurements were also made of the spectral distributions of the emission in the visible range; these distributions showed reasonable agreement with those predicted by the theory of Frank and Tamm. The use of standards based on the Cherenkov effect for the calibration of luminescence detectors using photomultiplier tubes, and for the absolute measurement of low intensities of visible light, is discussed. A.

535.242

3254. An interpretation of the bril scale of subjective brightness. W. C. MICHELS. *J. Opt. Soc. Amer.*, **44**, 70–4 (*Jan.*, 1954).

The *bril* scale, obtained from extensive experimental data by Hanes, represents an attempt to establish a subjective scale of brightness by the determination of particular luminances which produce specific ratios of brightness. This scale, like other scales obtained from fractionation data, necessarily assumes a one-to-one correspondence between intensity of stimulus and magnitude of response—an assumption in conflict with known facts regarding adaptation. It is shown that the reformulation of the Fechner law proposed several years ago, aided by results obtained from rating-scale techniques, can predict quantitatively all of the data used for the construction of the bril scale. Since this theoretical treatment takes explicit account of adaptation, it follows that each of the ratios determined by fractionation techniques has meaning by itself, but that the combination of these ratios into a scale of wide range is not justified. The fallacy involved in such combination is the assumption that a given stimulus is psychologically equivalent to itself when it is presented under different conditions, and, therefore, under different states of adaptation. A.

535.242.4

3255. Light modulation by means of openings in rotating cylinders. G. C. MÖNCH. *Optik*, **10**, *No.* 11, 567–70 (1953) *In German.*

An instrument is described which produces an amplitude-modulated light beam by means of a rotating cylinder. Oscilloscope recordings showing the waveforms are reproduced. A method of producing pure sine-wave modulation is also given. R. W. FISH

535.247.4

3256. Detection and recording of optical transients by photomultipliers. R. F. SAXE. Letter in *Nature* [*London*] **172**, 1198 (*Dec.* 26, 1953).

The question of signal/noise ratio is discussed as applied to photomultipliers used for recording optical transients much shorter than 1 μsec. Tables giving the output current and gain corresponding with accuracies of 10 and 1% are included. These show that the maximum linear output at present severely limits the useful gain, e.g. the RCA 931-A multiplier gives 1% accuracy when the gain is limited to 10^5, 10% accuracy when the gain is 10^7, the resolution time being $0{\cdot}5 \times 10^{-8}$ sec in each case. A. H. W. BECK

535.249 : 548.74

3257. Intensity measurement of the electron diffraction photograph. I. General principle. J. KAKINOKI. *J. Inst. Polytech. Osaka City Univ. B*, **1**, 21–31 (*Feb.*, 1950).

Describes a method for overcoming the disadvantages of the steep drop in background intensity in the intensity measurement of electron diffraction photographs by microphotometry. Instead of the usual rotating sector with its inherent difficulties of construction and adjustment, an arrangement is adopted whereby the photographic plate is set parallel to the direct beam at about 5 or 10 mm from it. J. THEWLIS

535.31

3258. On a method of solving an inverse problem in geometrical optics. A. L. MIKAÉLYAN. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 5, 933–6 (1952) *In Russian.*

If the wave fronts in a two-dimensional inhomogeneous medium, of refractive index $n = n_1(x,y)$ are

defined by $S_1(x,y) = \text{const.}$, any medium having refractive index $n(x_1y) = n_1(x_1y)S[S_1(x,y)]$ has the same family of wave fronts. This result is proved by obtaining a general from a particular solution of the eikonal equation. $S[S_1(x,y)]$ is an arbitrary function of $S_1(x,y)$, and hence all the inhomogeneous media having wavefronts defined by $S_1(x,y) = \text{const.}$ are known. There follow applications of the principle, in particular to Maxwell's classical "fish eye" problem.

H. H. HOPKINS

535.31

3259. Application of the method of co-ordinate systems to the construction of non-uniform media having given ray trajectories. A. L. MIKAÉLYAN. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 6, 1101–3 (1952) *In Russian.*

It is shown that the phase-velocity in a 2-dimensional medium, $v(u_1, u_2)$, is expressible in the form $v(u_1, u_2) = h_1(u_1, u_2)S(u_1)$, where (u_1, u_2) are orthogonal co-ordinates, $u_2 = \text{const.}$ represents the given trajectories, S is an arbitrary function, and $h_1(u_1, u_2)$ is a metrical coefficient of the co-ordinate system. It then follows that the trajectories $\psi_1(x, y) = \text{const.} = u_2$, having orthogonal wavefronts $\psi_2(x, y) = \text{const.} = u_1$, have the metrical coefficient $= [(\partial x/\partial u_1)^2 + (\partial y/\partial u_1)^2]$. Hence the equation of the medium is obtained at once. The method is illustrated by an example.

H. H. HOPKINS

535.31

3260. A new method of transporting optical images without aberrations. A. C. S. VAN HEEL. Letter in *Nature* [*London*] **173**, 39 (*Jan.* 2, 1954).

A bundle of plastic fibres is used to convey an optical image from one end to the other. The light falling on any one fibre is "trapped" by total internal reflection and is therefore conveyed to the other end of the fibre, an image formed on one end of the fibre-bundle being thereby transported point for point to the other end of the bundle. Metal-coated fibres were found to be unsatisfactory, and better transmission was obtained using plastic fibres of refractive index $\sim 1{\cdot}52$ coated with a thin layer of index $1{\cdot}47$ and a further thin layer of black paint. It appeared practicable to go down to $0{\cdot}1$ mm for the diameter of the core fibre. See also Abstr. 6594 (1953).

H. H. HOPKINS

535.31 : 535.8

3261. A flexible fibroscope, using static scanning. H. H. HOPKINS AND N. S. KAPANY. Letter in *Nature* [*London*] **173**, 39–41 (*Jan.* 2, 1954).

It has been shown experimentally that light is conducted (because of total internal reflection) along a borosilicate glass fibre 30 in. long and $0{\cdot}001$ in. diameter. If the fibre has a flat end-face the light entering the fibre is trapped in it providing the refractive index $> \sqrt{2}$. A method of aligning simple uncoated glass fibres to form an image-conveying bundle is described. This has been used to form a bundle of glass fibres $0{\cdot}25$ in. square in section. Each fibre had a diameter $= 0{\cdot}0025$ in., and the smallest detail visible should therefore be $\sim 0{\cdot}005$ in. Alignment of the fibres was found to be perfect when tested using the image of a straight edge, and the theoretical resolving power of 100 lines/inch was easily obtained. A photograph of the image of a simple test object is given.

H. H. HOPK

535.

3262. Image contract of some standard objects in stigmatic instrument. A. MARÉCHAL. *Rev. Opt.*, 649–60 (*Dec.*, 1953) *In French.*

The formula is briefly established and applied the following cases: a point, a black line, the e of a luminous field and a periodic structure. Examp show how quickly the method can be applied.

535.

3263. The determination of aspherical correct surfaces. F. I. HAVLIČEK. Letter in *Bull. sci. Cc Acad. Yougoslavie*, **1**, 13 (*Jan.*, 1953) *In German.*

A simple method is described to determine co-ordinates of the aspherical surface, using a const optical path criterion to link the trigonometrica traced ray from the previous surface with the requi emergent ray. An $f/2$ Petzval type lens is used illustrate the method.

R. W. H

535.

3264. The correction of anastigmatic triplets means of the differential expression of Seidel theo F. I. HAVLIČEK. Letter in *Bull. sci. Cons. Ac Yougoslavie*, **1**, 39–40 (*July*, 1953) *In German.*

A numerical example is given of lens design the calculation of the Seidel aberrational sums a their differential coefficients. A 50 mm trip anastigmat is determined by this method.

R. W. F

535.31

3265. The condition of equal irradiance and distribution of light in images formed by opti systems without artificial vignetting. F. WACHENDO *J. Opt. Soc. Amer.*, **43**, 1205–8 (*Dec.*, 1953).

It has been pointed out by several scientists t the $\cos^4$-law does not correctly describe the decre of marginal irradiance in images. It has also b repeatedly proven that it is theoretically and practica possible to avoid or even to overcorrect the margi decay. The equations developed for this purp should be amplified, however, and as many specifi tions as possible should be dropped. An attempt do so has resulted in deriving three formulae wh are described in this paper. One formula is a c dition to be fulfilled by systems with equal irradian over all the image. In systems not fulfilling t condition, the decrease of marginal irradiance can determined by two other formulae.

535.31

3266. The use of differences of Seidel coefficients the correction of optical systems. F. I. HAVLIČ *Optik*, **10**, *No.* 10, 475–8 (1953) *In German.*

A method is demonstrated whereby the necessa slight changes to the radii of an optical system ensure freedom from primary aberrations may readily calculated. The method is applied to the c of a triplet photographic lens, numerical results be given.

R. W. F

535.31

3267. A simple calculation of the surface coefficie of the aberrations of the third order. J. FLÜG *Optik*, **10**, *No.* 10, 478–9 (1953) *In German.*

New formulae are given for the coefficients third-order aberrations. These formulae are m

onvenient in use and readily allow the contributions f the individual lens surfaces to be calculated.

R. W. FISH

535.317.9

268. A three-dimensional method for the handling f optical problems. A. REUSCHEL. *Optik*, **10**, *No.* 10, 70–5 (1953) *In German.*

The passage of rays through a rotationally symmetrical lens is determined by the use of a three-imensional model. This is obtained by erecting a ime axis, normal to a cross-sectional plane containing he lens axis. The system is applied to the determination of the aspherical surface required to bring all ays from a single positive lens to a common focus. The method is said to have possibilities for he generation of aspherical surfaces in optical nanufacture.

R. W. FISH

535.321

269. The determination of the refractive indices of nhomogeneous solids by interference microscopy. R. C. FAUST. *Proc. Phys. Soc.* [*London*] *B*, **67**, 38–48 (*Feb.*, 1954).

The refractive indices of an optically inhomogeneous specimen will generally vary in directions both parallel o and perpendicular to the microscope axis. It is, however, possible to define a mean index μ_s such that $\mu_s \times$ specimen thickness) represents the optical thickness in a direction parallel to this axis. Interference microscopy reveals those parts of the specimen for which the mean index μ_s is equal to the refractive index of the immersion liquid. Thus, by gradually changing the index of the liquid relative to that of the specimen, one can determine the manner in which μ_s varies from region to region of the specimen. These changes in relative indices can be effected by altering either the wavelength of the incident light or the temperature of the system. In the wavelength variation method, which is applicable to specimens of thickness less than about 0·1 mm, the incident beam is of white light, and the fringe pattern is observed with the aid of a spectrograph. In the temperature variation method, which is useful for thicker specimens, monochromatic light is employed, the fringes being observed by direct microscopic examination. If the specimen is of convenient geometrical form it is possible to utilize these observed values of μ_s in order to calculate the refractive indices at any point in the interior of the specimen, but with irregularly shaped specimens one might have to resort to section cutting in order to achieve the same results. Application of these methods to anisotropic bodies enables conclusions to be drawn concerning the degree of molecular orientation and the closeness of molecular packing at different regions of the specimen.

A.

535.323 : 532.612

3270. Determination of the refractive index of monomolecular layers of fatty acids. E. HOFMEISTER. *Z. Phys.*, **136**, *No.* 2, 137–51 (1953) *In German.*

The refractive index n and surface tension σ of monomolecular layers of five fatty acids were measured by means of the surface reflection of polarized light and an apparatus due to Trurnit [Abstr. 2739 (1948)] respectively. Frazer's method used for the former measurement was corrected for incomplete extinction when the Nicol prisms are crossed, detection of extinction being photoelectric. The refractive indices of the layers are about 6% lower than those of the aggregate materials. n increases with molecular length. The discrepancy between molecular lengths, as calculated from surface tension and X-ray measurements respectively, is eliminated when the density value for the liquid is replaced by that for the solid phase.

R. A. WEALE

535.323 : 535.34 : 535.39

3271. On the optical constants of metals. A. VAŠÍČEK. *Czech. J. Phys.*, **1**, *No.* 3–4, 190–6 (1952).

The two alternative definitions of optical constants are discussed; the one, Drude's method, in which measurements taken at various incidence angles are used to give values of n_0 and k_0 at normal incidence, and the other in which measurements at a particular angle of incidence give constants n and k applying to that angle only. Measurements of the optical constants of mercury appear to show that Drude's constants n_0 and k_0, do in fact vary with the incidence angle used, and from these results and from other theoretical considerations it is concluded that the second of the two definitions is to be preferred.

D. G. AVERY

535.323 : 535.345 : 535.39 : 531.717

3272. On the simultaneous determination of the optical constants and of the thickness of thin absorbing films. D. MALÉ. *Ann. Phys.* [*Paris*] **9**, 10–51 (*Jan.–Feb.*, 1954) *In French.*

A new graphical method is described which enables simultaneous determination to be made of optical constants and the thickness of a thin film of a metal. This makes use of the measurement at normal incidence of reflection coefficients, transmission and in certain cases, the change of phase. The phase change measurement is necessary when very thin films or very high absorption coefficients are involved. It is shown that the properties of thin films can be explained by electromagnetic theory if it is postulated that the optical constants vary with the thickness. The theory is confirmed by observations made on thin films of silver and gold, produced both by cathodic sputtering and thermal evaporation. The values found differ somewhat from older values and it is demonstrated that the density of a deposited film is not equal to that of the bulk of metal, a fact which explains earlier errors. For gold the thermal evaporated and sputtered films have similar constants which differ from that of the bulk metal. An apparatus is described for the simultaneous production of five thin films of different thickness.

S. TOLANSKY

535.323 : 535.417

3273. The index of refraction of germanium measured by an interference method. D. H. RANK, H. E. BENNETT AND D. C. CRONEMEYER. *J. Opt. Soc. Amer.*, **44**, 13–16 (*Jan.*, 1954).

A high-precision determination of the index of refraction of high-purity germanium has been made by an interferometric method in the 2·0–2·4 μ region. Since the transmission of germanium in this region is very high, the optically plane parallel plate of germanium has been used as a Fabry–Perot interferometer. The change in index with temperature at 24·5°C has also been found. There is a definite

variation in the temperature coefficient of refractive index at different wavelengths near the absorption edge. The Cauchy constants for the index of refraction are $\mu_0 = 4{\cdot}0385$, $B = 2{\cdot}1345 \times 10^{-9}$, and $C = 5{\cdot}363 \times 10^{-17}$. A.

535.323–15

3274. Infrared index of refraction of tellurium crystals. P. A. HARTIG AND J. J. LOFERSKI. *J. Opt. Soc. Amer.*, **44**, 17–18 (*Jan.*, 1954).

The index of refraction of tellurium has been measured for single-crystal samples having 10^{17} impurity atoms/cm^3. The values were found to vary from 4·95 at 4 μ to 4·85 at 8 μ for radiation polarized with *E*-vector perpendicular to the *C*-axis and from 6·31 at 4 μ to 6·20 at 8 μ for the *E*-vector parallel to the *C*-axis. A.

535.33/.34

3275. Slit-width effects. S. BRODERSEN. *J. Opt. Soc. Amer.*, **44**, 22–5 (*Jan.*, 1954).

A general treatment is given of the effects of slit-widths upon emission lines, absorption lines and continuous absorption spectra. The fundamental approximation is a triangular shaped slit function of base $2s_{\text{eff}}$, where the effective slit-width s_{eff} is related to the geometrical slit-width s_g as $s_{\text{eff}}^2 = s_0^2 + s_g^2$, s_0 being a function of the frequency characteristic of the individual spectroscope. A formula is given for the observed shape of an emission line. The observed width L is derived from its ideal width l as $L^2 = l^2 + s_{\text{eff}}^2$. The same formulae are valid for absorption lines for sufficiently small values of the optical density D. For larger D the mathematical difficulties of a general treatment are insuperable, the more so because the superposition principle does not hold. For the maximum point it is shown that neither Beer's law nor Lambert's law is experimentally fulfilled in many cases. A correction term is given for the effect on absorption spectra linear in $\log \varepsilon$ *v.* cm^{-1}, where ε is the molar extinction coefficient. The possibilities of an experimental determination of the function s_0 are discussed on the basis of the formula $L^2 = l^2 + s_g^2 + s_0^2$. A.

535.33.03 : 536.46

3276. Effects of temperature gradients, self-absorption, and line shape on apparent rotational temperatures of OH. B. H. ELLIOTT AND S. S. PENNER. *J. chem. Phys.*, **22**, 101–5 (*Jan.*, 1954).

The effect on apparent rotational temperatures (of OH) of adjacent radiating and absorbing regions at different temperatures and of spectral line shape, coupled with varying degrees of self-absorption, has been studied. The calculations emphasize the fact that definitive conclusions regarding interpretation of flame spectra are difficult to obtain by use of conventional low-resolution spectroscopic studies of flames. Multiple path experiments, or absorption studies with a discrete line source, appear promising provided they are restricted to conditions under which the spectral line shape is known. A.

535.33.07

3277. Spectrophotometric measurements. A. V. IOGANSEN. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 4, 527–30 (1952) *In Russian.*

A mathematical discussion of the limits of applicability of Beer's and the additivity laws, strictly only for monochromatic radiation, to the us measurements over a definite band of wavelengt Formulae are derived from which the absorption strictly monochromatic radiation can be calcula from measurements made over a known band wi assuming that the absorption band has the same fo as the Gauss error function. R. C. MURI

535.3

3278. Method for crossing a Fabry–Perot eta with a Rowland circle spectrograph. R. G. LACOU *J. Opt. Soc. Amer.*, **44**, 35–6 (*Jan.*, 1954).

An etalon was crossed with a small conca grating spectrograph by forming the rings on vertical focus instead of the slit. Photographs ta on the Rowland circle and diameter of the gra sphere show the vertical astigmatism to be negligi Some limitations of the method are discussed.

535.3

3279. Adjustable instrument mount. L. S. BRO Letter in *J. Opt. Soc. Amer.*, **44**, 87 (*Jan.*, 1954).

A mounting for an echelle attachment to a spec graph is described. By means of three ball feet provides controlled rotation and translation in horizontal plane. R. W. H

535.33.07

3280. An automatic infra-red spectrophotome V. I. MALÝSHEV, M. N. MARKOV AND A. A. SHU *Dokl. Akad. Nauk SSSR*, **86**, *No.* 2, 273–6 (1952) *Russian.*

Description of a double-beam spectrometer. revolving mirror allows the two beams, blank filled, alternately to reach the entrance slit of a N prism monochromator. The detecting bolome which receives the out-of-balance radiation signa frequency 9 c/s, is part of a bridge circuit fed w 4000 c/s voltage and the bridge out of balance sig is amplified at this frequency. After detecti further amplification at 9 c/s, phase detection conversion to 50 c/s signal of appropriate phase, resultant signal is fed to a servomotor which dri the spectrophotometer wedge comb in the blank be and the recording pen which is mechanically attach The slits are opened gradually and the spectrum fr 2–15 μ takes about 30 min. D. H. WHIF

535.33.07

3281. Spectrometers with echellette gratings in infrared between 0·9 and 3 μ. G. HEPNER. *J. Ph Radium*, **14**, 717–23 (*Dec.*, 1953) *In French.*

The Pfund mounting is compared with that Finkelstein which uses the grating in the blaze at wavelengths. It is shown that with the grat available the advantage of the latter mounting is because of the loss of aperture and the mechani complexity. The aberrations of the Pfund mount are calculated. G. F. LOTH

535.33.07–15 : 538.222 : 538.565 : 621.37.02

Introduction to microwaves and their scient applications. *See Abstr.* 3679

535.33.071 : 522.

The Oxford solar spectroscope. *See Abstr.* 3022

535.337–14 : 538.615

282. Theory of the microwave Zeeman effect in omic oxygen. A. ABRAGAM AND J. H. VAN VLECK. *hys. Rev.*, **92**, 1448–55 (*Dec.* 15, 1953).

Slight deviations of the coefficient of the linear eeman term from the elementary Landé value arise om the following effects: (*a*) small departures from ussell–Saunders (R-S) coupling, (*b*) the motion of ne nucleus, (*c*) relativity corrections, (*d*) interplay etween the magnetic field and various kinds of agnetic interactions within the atom, and (*e*) the chwinger electrodynamical corrections. In the resent paper an effort is made to estimate the agnitude of the effects (*a*), (*b*), (*c*), (*d*) with the goal f examining whether the residual discrepancy between awson and Beringer's measurements on oxygen and he ideal Landé value is in accord with Schwinger's ormula for (*e*). The effect (*d*) may be further divided nto modulation by the magnetic field, or Larmor recession, of (d_1) ordinary spin-orbit, (d_2) spin-other-rbit and (d_3) orbit-orbit interaction. The theory for *c*) and (d_1) has already been developed by Margenau nd Breit, and (d_2) to a certain extent by Lamb, while hat for (*b*) was first given by Phillips. The corrections *d*) can in each case be obtained by substituting $\mathbf{p} + eA/c$ for **p** in the corresponding magnetic inter-ction terms in the Pauli two-component Hamiltonian unction, but can also be derived more fundamentally rom the four-component Dirac equation. From the tandpoint of the Dirac equation, the segregation of *c*) from other magnetic effects is rather artificial, but *c*) has the simple physical interpretation that it is antamount to substituting the transverse mass for he rest mass in the ordinary Zeeman energy. The umerical estimate of effects (*b*)–(*d*) requires knowing he wave functions in some detail. Certain rather rude approximations are made in the present paper, ncluding omission of exchange terms in some places. However, the agreement between the calculated and bserved Zeeman coefficients after all the corrections *a–e*) are included is gratifying. A.

535.338 : 537.561

Direct production of molecular electron spectra using the mass spectrometer. *See Abstr.* 3612

535.338.3

3283. An approximate method of calculation of the probability of optical transitions. L. A. VAĬNSHTEĬN AND B. M. YAVORSKIĬ. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 6, 919–22 (1952) *In Russian.*

In distinction to Slater's approximate wave functions the radial functions for excited optical levels are chosen to be orthogonal to those for the lower levels with the same *l*. These functions give an order of magnitude estimate of the transition probability; the error resulting from employing them lies generally between 0 and 100%. G. E. BROWN

535.338.32

3284. The quenching of mercury resonance radiation. III. The total effective cross sections of some saturated compounds. B. DEB. DARWENT AND M. K. PHIBBS. *J. chem. Phys.*, **22**, 110–13 (*Jan.*, 1954).

For Pt II, see Abstr. 733 (1953). Total effective cross-sections were measured for 22 compounds in the processes $^3P_1 \rightarrow {}^3P_0$ and $^3P_1 \rightarrow {}^1S_0$, by which mercury resonance radiation is quenched. The compounds include the methylamines, methyl halides, methyl alcohol, dimethyl ether, H_2S, ethyl mercaptan, dimethyl sulphide, ethylene oxide, cycloparaffins and dimethyl mercury. The cross-sections varied from less than 0·01 Å^2 (fluoroform) to 46 Å^2 (dimethyl mercury). In general σ_Q^2 is increased when a carbon atom is replaced by oxygen and even larger increases occur when the substituting atom or group is, or contains, nitrogen, sulphur, or mercury. The presence of halogens, except fluorine, increases σ_Q^2; the introduction of fluorine reduces the cross-section. A.

535.338.332 : 539.152.2

3285. Hyperfine structure of the spectrum of Zr I and the magnetic moment of Zr^{91}. S. SUWA. *J. Phys. Soc. Japan*, **8**, 734–9 (*Nov.–Dec.*, 1953).

The h.f.s. of the spectrum of Zr I was investigated, a natural zirconium sample being used; and in some lines the h.f.s. of Zr^{91} was observed. The magnetic moment of Zr^{91}, calculated from the measured splittings in the line $\lambda 4687{\cdot}80$ ($4d^3 5s^5 F_5 - 4d^3 5p^5 G_6$) and other lines, is $\mu(Zr^{91}) = -1{\cdot}3 \pm 0{\cdot}3$ nm. A.

535.338.333

3286. Isotope shift in the $_{58}$Ce II spectrum. H. ARROE. *Phys. Rev.*, **93**, 94 (*Jan.* 1, 1954).

The spectrum of Ce II from enriched samples of Ce^{136} and Ce^{138} has been studied and compared with the same spectrum from natural Ce. Only a negligible isotope shift, certainly less than 6% of that between the isotopes with 82 and 84 neutrons, has been found between the isotopes with 78, 80 and 82 neutrons.

A.

535.338.333

3287. Isotope shifts in the atomic spectrum of calcium. A. PERY. *Proc. Phys. Soc.* [*London*] *A*, **67**, 181–5 (*Feb.*, 1954).

The isotope shift in several spectral lines of Ca^{40} and Ca^{48} has been measured. A triplet of the arc spectrum shows a specific mass effect a little larger than the normal mass effect and in the opposite direction. In the resonance line and a doublet of the spark spectrum the specific mass shift is very small and in the same direction as the normal shift. Comparison with analogous transitions in magnesium indicates that the specific mass effect shows a similar behaviour in both elements. A.

535.338.4

3288. On spectral characteristics of ozoniser discharge in pure nitrogen at 20 mm pressure. N. APPALANARASIMHAM. *Indian J. Phys.*, **27**, 31–8 (*Jan.*, 1953).

A large number of known band systems are excited involving the following initial electronic levels, $D^3\Sigma_u^+$, $C^3\Pi_u$, $B^3\Pi_g$, $c_2\,{}^1\Sigma_u^+$, $m\,{}^1\Pi_u$, l, $s'\,{}^1\Sigma_u^+$, $h\,{}^1\Sigma_u^+$, $r'\,{}^1\Sigma_u^+$, z, $y(^1\Pi_g)$ and $x(^1\Sigma_g^-)$, with relative intensities visually estimated, ranging from 100 in the case of second positive to 0·5 for the first positive system of bands with 30 for the fourth positive and 20 for the singlet systems. Also, the first negative bands of N_2^+ are excited with intensity 60 in the above scale. Besides, there is evidence of three progressions of new bands which probably involve transitions from hitherto unknown electronic singlet levels to the $a\,{}^1\Pi_g$ state. It is generally accepted that excitation of a molecule

by electron collisions favours such excited states for which the inter-nuclear distance is not much different from that of the lower state while excitation by collisions with ions or atomic particles favours excited states which have greatly altered inter-nuclear distances. From this principle the excitation of the $D^3\Sigma_u^+$ state ($r_e = 1{\cdot}108$) and of $B^2\Sigma_u^+$ of the first negative bands of N_2^+ ($r_e = 1{\cdot}075$) can be understood to be due to collisions of normal N_2 molecules with high speed electrons while that of the singlet electronic levels which involve a big change in the inter-nuclear distance (from 1·22 and 1·33 to 1·094, the r_0 in the ground state) is due to collisions with particles of atomic masses. The excitation of all these states simultaneously in the ozonizer discharge, indicates the significance of this type of discharge. The abnormally low intensity of the first positive bands in this type of ozonizer discharge is attributed to deactivation of the initial electronic level $B^3\Pi_g$, due to collisions with atomic particles and a possible radiationless transfer to repulsive states. A.

535.338.4

3289. The band spectrum of nickel fluoride. V. G. Krishnamurty. *Indian J. Phys.*, **27**, 354–8 (*July*, 1953).

A characteristic band spectrum of NiF was obtained using a heavy current discharge from a 2 kW, d.c. generator. Regularities in wave number interval have led to the suggestion of a $^2\Pi$–$^2\Sigma$ as the electronic transition giving rise to the band heads. The value of the ground state vibrational frequency obtained for this band system is 740 cm^{-1} approximately. A.

535.338.4

3290. Spectrum of the AlC molecule. P. B. Zeeman. *Canad. J. Phys.*, **32**, 9–15 (*Jan.*, 1954).

An extensive system of bands in the visible and near infrared regions of the spectrum has been observed in emission when aluminium is present in a King Furnace. These bands have been attributed to the AlC molecule. No metallic carbide spectrum has been described before. A vibrational analysis of the bands has been made. The values $\omega'_e = 278{\cdot}79_5$ and $\omega''_e = 350{\cdot}01_1$ kaysers were obtained. A.

535.338.4 : 537.525.8

3291. Spectroscopic studies of ozoniser discharges. III. Effect of irradiation on the intensity distribution of the second positive nitrogen bands. N. Appalanarasimham. *Indian J. Phys.*, **26**, 512–18 (*Oct.*, 1952).

The intensities of the second positive nitrogen bands obtained in an ozonizer discharge through nitrogen at different voltages of excitation with and without irradiation by 3650–60 Å group of radiations of mercury, were measured using photographic photometry. It was found that the irradiation brings about a general decrease in the intensities of all the bands and further that a redistribution of the intensities of the bands occurs in such a way that the percentage decrease of the intensities has the following order: (0,3) > (0,2) > (0,1). Also the percentage decrease in the intensity of the (1,3) band is greater than that of (0,2) band. While the general decrease in the intensities of all the bands is a consequence of the reduction in the number of collisions of the neutral nitrogen molecules with electrons and/or ions, the redistribution in intensity is to be attributed to alteration of the velocities of ions and particles atomic masses. The redistribution in the intens of the bands (0,1), (0,2) and (0,3) and (1,3) and of the v''-progressions of $v' = 0$ and 1 respectivel suggested to be due to induced perturbation of low v'' levels, e.g. $v'' = 2$, brought about by irra tion. A comparative study of the intensities of second positive bands obtained in low pres induction coil discharges through nitrogen and with those obtained in the present experiments, sh that external irradiation alters the intensity distr tion of the bands in just the same manner as substitution of air for nitrogen does, the other c ditions remaining the same.

535.338.4 : 551.5

3292. The Herzberg bands of O_2 in an oxy afterglow and in the night-sky spectrum. H. Broida and A. G. Gaydon. *Proc. Roy. Soc.* **222**, 181–95 (*March* 9, 1954).

An afterglow of flowing oxygen in an unconden discharge at around 2 mm pressure shows $^3\Sigma_u^+$–$^3\Sigma_g^-$ system of O_2 in emission. Measurem and photographs are presented. The values o assigned by Herzberg from the absorption spect require raising one unit. The afterglow bands compared with the night-sky spectrum; it is conclu that the Herzberg bands are present in the night but that a few bands previously attributed to system do not belong to it. The intensity distribu of the system is discussed. The bands are prob excited by recombination of oxygen atoms. afterglow spectrum also shows the green auroral and the "atmospheric" band of O_2 at 7593 Å. A weak bands around the blue region may be due new intercombination system of O_2, $^3\Sigma_u^+$–$^$ Diffuse bands in the air afterglow appear to be du NO_2. The air afterglow may be responsible for s of the night-sky continuum.

535.343 : 539.

Absorption spectra of triarylmethyl. *See Abstr.* 3

535.343 : 539.

3293. Electronic spectra of molecules containing and five membered rings. I. Calculation of ene levels. G. Viswanath. *Indian J. Phys.*, **27**, 25 (*May*, 1953).

Using the atomic orbital method the region absorption of the indene molecule has been predic at λ3228 which agrees fairly with the experimer value at λ2952.

535.343

3294. Pressure broadening of linear molecules H. Feeny, H. Lackner, P. Moser and W. V. Smi *J. chem. Phys.*, **22**, 79–83 (*Jan.*, 1954).

A microwave spectroscope, especially designed studies of the temperature dependence of microw line widths is described. With this spectroscope, line width of the $J = 1 - 2$ OCS line has b measured over a temperature range from 195°K 476°K. Over this range, the line width varies $T^{-0.9}$. An interpretation in terms of intermolecu forces is deferred, pending work with other lin molecules and other transitions.

535.343–14

3295. Microwave spectroscopy. W. GORDY, W. V. SMITH AND R. F. TRAMBARULO. *London: Chapman and Hall*, xii + 446 *pp.*

Review in *Brit. J. appl. Phys.*, **5**, 78 (*Feb.*, 1954).

535.343–14 : 539.132

Microwave spectra of methyl mercury chloride. *See Abstr.* 3721

535.343–14 : 539.153

3296. Observations of magnetic resonance of several quanta in a beam of sodium atoms oriented optically. J. BROSSEL, B. CAGNAC AND A. KASTLER. *C.R. Acad. Sci. [Paris]* **237**, 984–6 (*Oct.* 28, 1953) *In French.*

In a beam of Na atoms in the $^2S_{\frac{1}{2}}$ state in a magnetic field from 120–220 gauss, transitions at 108·5 Mc/s occur not only at fields such that $\Delta m_f = \pm 1$, but also $m_f = \pm 2$ and $\Delta m_f = \pm 3$ the energy being absorbed as two or three separate quanta respectively. The new transitions are much narrower in field range and are only observed at high radiofrequency powers. Detection is through reduction of the circularly polarized orienting light signal. D. H. WHIFFEN

535.343–15

3297. Shape of the C–H absorption band in liquid chloroform. V. M. CHULANOVSKIĬ. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 6, 1273–6 (1952) *In Russian.*

It is attempted, on the basis of the published and some new experimental results, to throw some light on the formal similarity between the formula for the intensity distribution in the infrared C–H absorption bands in liquid $CHCl_3$ and $CHBr_3$, and the Lorentz formula for the low-density gases. Several different cases are analysed of the possible complication of the band, in analogy to the perturbation mechanism known to take place in gases. It is deduced from Lorentz' formula that D_0 (the band half-width) should be $= \nu_m/\pi$ (where ν_m is the wave number of intermolecular vibrations). Experimental evidence obtained in the author's laboratory shows indeed that, for liquid systems where ν_m varies from 14 to 30 cm^{-1}, the D/ν_m ratio is very near 1/3.

F. LACHMAN

535.343–15 : 535.375.5

3298. The vibrational spectra of *n*-dimethylaminodiborane. D. E. MANN. *J. chem. Phys.*, **22**, 70–8 (*Jan.*, 1954).

The infrared and Raman spectra of $(CH_3)_2NB_2H_5$, and its deuteriated relative, $(CH_3)_2NB_2D_5$, were determined. A satisfactory vibrational assignment has been achieved. A.

535.343–15 : 539.132

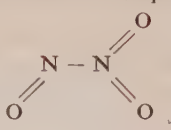
3299. The infrared spectrum and molecular constants of $C^{14}O_2$. A. H. NIELSEN AND R. T. LAGEMANN. *J. chem. Phys.*, **22**, 36–9 (*Jan.*, 1954).

A detailed account of the appearance of and the constants derivable from the infrared absorption spectra of the active fundamentals ν_2 and ν_3 of $C^{14}O_2$ is given. The following constants have been determined: $\nu_2 = 632{\cdot}20\ cm^{-1}$, $\nu_3 = 2225{\cdot}85\ cm^{-1}$, $B_{000} = 0{\cdot}39078\ cm^{-1}$, $\alpha_3 = 0{\cdot}00293\ cm^{-1}$. The harmonic frequencies ω_i and the anharmonic constants x_{ij} for the three isotopic species have been determined. Excellent agreement is obtained between observed and calculated band centres. A.

535.343–15 : 539.133

3300. On the infrared spectrum and the structure of nitrous anhydride. L. D'OR AND P. TARTE. *Bull. Soc. Roy. Sci. Liège*, **22**, 276–84 (*June–July*, 1953) *In French.*

The infrared spectrum of the N_2O_3 molecule has been determined by comparison of the observed spectra of the mixtures NO_2–N_2O_4 and NO_2–N_2O_4–NO. This experimental evidence is completely in favour of the structure



for the nitrous anhydride molecule. G. I. W. LLEWELYN

535.343–15 : 539.133

On the spectroscopic behaviour of the polyacenes. *See Abstr.* 3737

535.343–15 : 612.84

3301. The infrared absorption of the crystalline lens. J. LENOBLE AND Y. LE GRAND. *Rev. Opt.*, **32**, 641–8 (*Dec.*, 1953) *In French.*

Measurements were made between 1 μ and 2·4 μ on 8 crystalline lenses of rabbits, using an apparatus which avoided the error due to the convergence of the lenses. The results show that the absorption is due mostly to water which forms about 74% of the crystalline lens, with its own 3 absorbing bands at 1·2–1·7 and above 2 μ, the 1·7 μ band being the most marked. A.

535.343–31

3302. Ultraviolet absorption spectra of diphenyl in the liquid and solid states. A. R. DEB. *Indian J. Phys.*, **27**, 305–10 (*June*, 1953).

Thin films of diphenyl of different thicknesses in the liquid state at 80°C and solid state at 30°C and −180°C were studied. It was observed that the very broad band lying in the region 2900 Å to 2300 Å in the spectrum due to the liquid is split up into two broad bands at 36 306 and 37 386 cm^{-1} in the case of the solid at 30°C. There are also indications of broad feeble bands up to about 2850 Å. When the solid is cooled to −180°C these feeble bands become sharper and are clearly resolved into nine distinct narrow bands, and each of the two broad intense bands observed in the case of the solid at 30°C splits up into four components at the low temperature. The significance of these results is discussed. It is pointed out that these new feeble bands of the solid at −180°C may be due to transitions in one of the phenyl rings with the second one in the excited state. A.

535.343.2 : 548.7

Iodide impurity absorption in potassium and sodium bromides. *See Abstr.* 3999

535.343.2 : 548.7

Features of spectra of smoky quartz as indications of the structure of its colour centres. *See Abstr.* 3995

535.343.32

3303. Complex formation and term-splitting in the rare earth absorption spectrum. L. HOLLECK AND D. ECKARDT. *Z. Naturforsch.*, **8a**, 660–4 (*Oct.*, 1953) *In German.*

Visible-region absorption spectra of complexes in

aqueous solution of Nd, Pr, and Sm with various organic acids are investigated with a spectrograph and a photoelectric spectrophotometer. The structures of the spectra due to "internal Stark effect" are found to depend on the nature and proportions of the complex components and on the pH. The ground term separation of 220 cm^{-1} for the Pr-citrate complex corresponds with the value found in the crystalline state. G. F. LOTHIAN

535.343.32 : 535.372

3304. Electronic and vibrational energy of tetrahydrofluorocyclene in benzene solution. Z. MAŁKOWSKI. *Bull. Acad. Polon. Sci. Cl.* 3, **1**, *No.* 3–4, 113–17 (1953).

The absorption and fluorescence spectra of the solvent molecules are measured. It is concluded from the banded structure of the spectra that the carbon atoms of the central octadiene ring of the molecules are responsible for fluorescence and absorption in the longer wavelength regions of the spectra. Absorption at shorter wavelengths resembles that for pure naphthalene solutions. G. F. J. GARLICK

535.343.4

3305. Fine structure of the Schumann–Runge bands near the convergence limit and the dissociation energy of the oxygen molecule. P. BRIX AND G. HERZBERG. *Canad. J. Phys.*, **32**, 110–35 (*Feb.*, 1954).

The Schumann–Runge absorption bands of O_2 ($B^3\Sigma_u^- - X^3\Sigma_g^-$) have been photographed in the fourth order of a 3 m vacuum spectrograph with a resolution of 160 000. Some spectra were taken with the O_2 at liquid air temperature. A detailed fine-structure analysis has been carried out for all bands with $v' > 11$. In addition to the six main branches (with $\Delta J = \Delta N = \pm 1$), for low values of the quantum number N(total angular momentum apart from spin), several lines of the six satellite branches (with $\Delta N = \pm 1$, $\Delta J = 0, \pm 1$) as well as of the two "forbidden" branches (with $\Delta N = \pm 3$, $\Delta J = \pm 1$) have been identified. Values of the rotational constants and the vibrational quanta in the upper state have been derived up to $v' = 21$. The triplet splitting increases rapidly with N and with v'; it cannot be described accurately by the known theoretical formulae. The origin of the 21–0 band is at 57 115 cm^{-1}. A very short extrapolation gives the convergence limit at 57 128 ± 5 cm^{-1}. This limit agrees excellently with the one derived from the near ultraviolet ($A^3\Sigma_u^+ - X^3\Sigma_g^-$) bands if it is assumed that at both limits those O atoms that are produced in the ^3P state are in the lowest component level of this state, viz. $^3P_2$. A discrepancy pointed out earlier by Herzberg is thus removed. The convergence limit just mentioned and certain other data derived from the spectrum lead to very precise information about the dissociation energy of O_2. Without any extrapolation the dissociation energy into normal atoms can be given as 41 260 ± 15 cm^{-1} (or $5{\cdot}114_8$ ± 0·002 eV or 117·96 ± 0·04 kcal/mole), which is 0·63% higher than the old value. A.

535.343.4 : 535.329 : 539.132

3306. The anomalous dispersion at the lines of the yellow-green bromine vapour bands. H. FAISSNER. *Z. Naturforsch.*, **8a**, 633–45 (*Oct.*, 1953) *In German.*

A Jamin refractometer is used in conjunction with a spectrograph. The dispersion of a glass plate in one beam of the refractometer gives tilted fringes which is superposed the anomalous dispersion of Br_2 absorption lines to give "hook"-shaped fring The wavelength distances between maxima minima may be measured directly or calculated f variations of the fringe pattern with pressure (ei pure Br_2 or a Br_2–H_2 mixture). The theory is g for the calculation of oscillator strengths from t measurements. The equivalent line-intensities acc with the Franck–Condon principle. G. F. LOTH

535.343.4 : 539

3307. Analysis and theory of the visible electr spectrum of the thiophosgene molecule. J. DUCHE *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 8–9, 697– (1953) *In French.*

The system of absorption bands of $CSCl_2$ betw 5710 and 3990 Å is analysed. The fundamental quencies of the excited electronic state are dedu the excited molecule has the same symmetry (as the normal molecule. Probable values are obta for the force constants in the vibration pote functions for both states. The results indicate the nature of the electronic transition is $n \rightarrow$ The dimensions of the excited molecule are dedu from a discussion of the bonding effects of electr in various n and π orbitals. A. J. TAY

535.343.4

3308. Preliminary work on the microwave spect of acetic acid. J. H. N. LOUBSER. Letter in *J. c Phys.*, **21**, 2231–2 (*Dec.*, 1953).

535.343.4

3309. One-to-two millimeter wave spectrosc III. NO and DI. C. A. BURRUS AND W. GORDY. *P Rev.*, **92**, 1437–9 (*Dec.* 15, 1953).

For Pt II, see Abstr. 1174 (1954). Pure rotatio transitions of $N^{14}O^{16}$ and DI^{127} were measure the one-to-two mm wave region. For NO $J = \frac{1}{2} \rightarrow \frac{3}{2}$ transition in the $^2\pi_{\frac{1}{2}}$ electronic gro state was observed. The transition reveals a doublet with separation $\Delta\nu_{dc} = 355{\cdot}1$ Mc/s. E component of the Λ doublet is further split into hyperfine components as a result of the nuc magnetic coupling of N^{14}. Nuclear quadru coupling of N^{14} was found to be small in compari with the magnetic interaction. Analysis of the d yields $B_0 = 50\,818{\cdot}0$ Mc/s, $r_0 = 1{\cdot}1540$ Å, B $51\,084{\cdot}8$ Mc/s, and $r_e = 1{\cdot}1510$ Å for the $^2\Pi_{\frac{1}{2}}$ st For DI^{127} the following information was obtain $B_0 = 97\,537{\cdot}2$ Mc/s, $r_0 = 1{\cdot}6165$ Å and $eQq(I^{127})$ 1823 ± 1 Mc/s. Nuclear magnetic interactions I^{127} were also detected and analysed.

535.343.4–15 : 539.

3310. The infrared spectrum and molecular consta of sulfur dioxide. R. D. SHELTON, A. H. NIELSEN W. H. FLETCHER. *J. chem. Phys.*, **21**, 2178–83 (*D* 1953).

By means of an infrared prism-grating spec meter equipped with a multiple-path cell, 17 vib tion-rotation absorption bands of SO_2 were obser and recorded. Seven bands exhibiting rotatio structure were analysed for the rotational consta of the upper and lower vibrational states. Harmo and anharmonic constants in the vibrational ene expression have been calculated, and suitable va

or the force constants in a four-constant potential unction have been obtained. No bands ascribable to $S^{34}O_2^{16}$ were found. A.

535.343.4–31

3311. Absorption coefficients of nitrogen oxide in the vacuum ultraviolet. F. F. MARMO. *J. Opt. Soc. Amer.*, **43**, 1186–90 (*Dec.*, 1953).

Using a photoelectric method, absorption coefficients of nitrogen oxide were measured in the spectral region 1100–2300 Å. Pressures from 0·3 to 100-mm Hg were used in the absorption cell with LiF windows. A continuous absorption spectrum was found in the region 1100–1400 Å where the absorption coefficients varied from about 40 cm^{-1} to 200 cm^{-1}. At the Lyman α line of hydrogen at 1216 Å the value was 67·5 cm^{-1}. A number of weak diffuse bands was also observed in the same region. These bands suggest preionization, since they appeared at wavelengths below about 1320 Å. The relative intensity distribution of the known bands (β, δ, ε, γ) at longer wavelengths were obtained at various pressures and are discussed. A.

535.343.9

3312. Excitons in crystals of cuprous oxide. E. F. GROSS AND B. P. ZAKHARCHENYA. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 5, 745–8 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-122.

By using 20 μ thick Cu_2O plates a hydrogen-like series of "exciton" absorption lines is found displaced in position from the series found in thicker specimens [Abstr. 5389–90 (1953)], the latter series being much weaker in the thin specimens. The structure in the continuous absorption region is also more marked. The results indicate the existence of two close or overlapping lattice bands (either conduction or filled bands). G. F. J. GARLICK

535.343.9

3313. On the absorption law for samples of non-uniform concentration with special reference to the spectroscopy of irradiated glasses. I. G. ROSS. *J. Opt. Soc. Amer.*, **44**, 40–4 (*Jan.*, 1954).

The dependence of optical density upon extinction coefficient is examined for light absorption measurements in which the number of absorbing molecules encountered by each ray of the measuring light is not constant. Some general results applicable to all such situations are derived. Particular attention is given to measurements of the absorption spectra of molecules produced by transverse irradiation of rigid solutions (triplet-triplet spectra). The conditions are determined under which such absorption is most intense, and the deviation from proportionality between optical density and extinction coefficient is least. A.

535.343.9–15 : 535.391

3314. Reflection and transmission spectra of different modifications of silica in the infrared region. V. A. FLORINSKAYA AND R. S. PECHENKINA. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 6, 1265–8 (1952) *In Russian.*

Presents the results of a research on these spectra in the region up to 14 μ for different modifications of SiO_2 (reflection spectra for low-temperature crystalline quartz, quenched crystalline quartz, fused quartz, and low-temperature tridymite and cristobalite in powder form; transmission spectra for low-temperature quartz, tridymite and cristobalite, quenched crystalline quartz, and pure silicic acid with 20% water). A mirror monochromator with a 60° rocksalt prism, and a thermopile with a multiplier were used. The reflection was measured in non-polarized light (constant angle of incidence = 13°). The transmission was measured with the aid of a Beckman spectrophotometer. Some characteristic maxima were observed for tridymite and cristobalite. F. LACHMAN

535.345 : 537.226.2

3315. Absorption of light and dielectric constant of alkali halide crystals. A. A. VOROB'EV. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 2, 157–8 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-67.

For potassium and sodium halides there is a linear relation between the spectral absorption edge frequency or energy and the square of the optical dielectric constant. The data show that the binding energy of the electrons decreases as the polarizability of the ions increases. G. F. J. GARLICK

535.345–31

3316. Transparency in the far ultraviolet of quartz samples, fused in a solar furnace in various atmospheres. M. FOËX AND A. JOHANNIN-GILLES. *C.R. Acad. Sci. [Paris]* **237**, 1668–70 (*Dec.* 21, 1953) *In French.*

The transparency of fused quartz in the far u.v. is known to depend upon impurities. The use of the solar furnace allows samples to be prepared, free from contamination by electrodes, refractories, etc., but in strictly controlled atmospheres. Curves are shown for transparency in the region 1600–2200 Å with atmospheres of oxygen, argon, etc. It is concluded that quartz fused in an oxidizing atmosphere is more transparent in this region. R. W. FISH

535.37

3317. The connexion between blackening and possibility of luminescence in zinc sulphide. H. GOBRECHT AND W. KUNZ. *Z. Phys.*, **136**, *No.* 1, 21–5 (1953) *In German.*

ZnS milled dry was reduced in luminescence under 3660 Å radiation. At the same time there was a decrease in the blackening produced by exposure to a quartz mercury arc in damp air. The blackening S was approximately proportional to log L, where L is the luminescence. When L was reduced by incorporating various amounts of Co into the phosphor at 900°c, it was found that log S was approx. proportional to L. For pure ZnS fired in H_2S at various temps., L increased to a max. at 1000°c and decreased above. S varied very similarly with temp. Incorporation of Cu activator in ZnS shifted the sensitivity for blackening towards longer wavelengths. S. T. HENDERSON

535.371

3318. Effect of the flux on the localization levels of electrons in ZnS–Cu phosphor. N. V. ZHUKOVA. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 5, 981–4 (1952) *In Russian.*

Presents results of an investigation on the effect of fluxes (LiCl, NaCl, KCl) incorporated into a luminophor (Cu-activated ZnS). A special apparatus has been devised, enabling a linear relationship to be

obtained between the heating time and the temperature of the excited phosphor. The fluxes have been found to cause, in general, the merging into one another of the maxima in the temperature stimulation curve, this effect increasing with the concentration of the flux and also in the sequence KCl, NaCl, LiCl. It is deduced that the incorporation of these fluxes does not bring about any new disturbances in the crystal lattice; the flux atoms arrange themselves near the existing lattice defects, i.e. the atoms of the activator.

F. LACHMAN

535.371

3319. Thermal quenching of fluorescence in biacene solutions. K. Rosiński. *Bull. Acad. Polon. Sci. Cl.* 3, **1**, *No.* 1–2, 55–9 (1953) *In French.*

The variation of fluorescence with temperature is studied for a solution of biacenaphthylidene in a silicone (DC703). Analysis of the results gives a value of 8·5 kilocal/mole for the activation energy in the quenching process. G. F. J. GARLICK

535.371

3320. On the origin of the various emission bands in CaS–Bi phosphors. V. F. Tunitskaya. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 3, 507–10 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-*105.

By using the properly purified raw materials it is shown that Bi produces only two emission bands in CaS phosphors, one with maximum at 390 mμ and the other with maximum at 450 mμ. By using Na sulphate or Li carbonate as a flux the 390 mμ is almost completely suppressed and the 450 mμ band enhanced. X-ray analysis shows that without flux a CaO–CaS–Bi phosphor results, and with flux only a trace of CaO is present, so that it is likely that only the 450 mμ is characteristic of CaS–Bi phosphors.

G. F. J. GARLICK

535.371

3321. Thermal decay of the luminescence of KBr. G. W. Williams, S. R. Usiskin and A. J. Dekker. *Phys. Rev.*, **92**, 1398–402 (*Dec.* 15, 1953).

The thermal decay of the luminescence of KBr, excited by X-rays, was investigated over a temperature range between $-77°$ and 250°c. The intensity of the luminescence as a function of the time after irradiation can be represented by a formula of the form:

$$I = \sum_n I_{on} \exp\left(\frac{-t}{Ae^{\varepsilon_n/kT}}\right)$$

The thermal activation energies ε_n have been determined. A.

535.371

3322. Fluorescence of crystallized fluorene. P. Pesteil and L. Pesteil. *C.R. Acad. Sci.* [*Paris*] **238**, 75–7 (*Jan.* 4, 1954) *In French.*

535.375

3323. On the Raman spectrum and structure of 1.3.5-triphenyl benzene. S. K. Mukerji, L. Singh and R. S. Singh. *Indian J. Phys.*, **27**, 341–6 (*July*, 1953).

The Raman spectra of *s*-triphenyl benzene in various solutions have been studied for the first time. The spectrum resembles that of other substances of the diphenyl benzene family. The Raman frequencies obtained agree in most cases with those of diphe and of the ortho-, meta- and para-diphenyl benz of this series investigated by previous authors. frequencies observed and found in all these vari solutions are at 3046(1), 2987(4), 1603(8), 1406 1458(5), 1350(6bd), 1238(4), 1045($\frac{1}{2}$), 1003(10), 603 406(1), 384(5), 234(1), 170(5), 146(5) and 87(4) cm respectively. The results are discussed with re ence to the Raman spectra of diphenyl and of orth meta- and para-diphenyl benzene. A comparat study of the spectra observed in all these substan lends support to the view that the substituent rings this compound cannot be very appreciably tilted fr the plane of the central ring.

535.37

3324. Temperature dependence [of the intensity] Raman lines. Ya. S. Bobovich and D. K. Ark penko. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 2, 247- (1952) *In Russian.*

Measurements were made of the intensities, ~ 25 and $\sim 52°$c, of various Raman lines in C $CHCl_3$, $C_6H_5NO_2$, *o-*, *m-* and *p*-nitrotoluene, latter dissolved in CCl_4 and also solid. The chan in intensity of three lines for CCl_4 and $CHCl_3$ are agreement with the results obtained by Fishk (1950). The intensities of the lines of the other s stances all decrease with temperature, except *p*-nitrotoluene (and naphthalene) in the solid st where they increase. It is concluded (1) that V kateswarlu's (1947) supposition about the effect anharmonicity on the change of intensity with te perature is incorrect and does not explain the obser anomalies; (2) that the difference between the te perature dependencies for the same liquid and so substance indicates the intramolecular character the anomaly. The anomalous decrease of inten with temperature for liquids and solutions (exist theory predicts an increase) may be due to a cert degree of order in the liquid state. R. C. MURF

535.37

3325. The Raman spectra of 1, 1, 1- and 1, 1, 2- chloroethane in the solid state at $-180°$c. D. Biswas. *Indian J. Phys.*, **27**, 379–83 (*July*, 1953).

The Raman spectra were investigated and co pared with those due to the two substances in liquid state. It was observed that in the case 1, 1, 1-trichloroethane all the prominent Raman li due to the liquid appear when the liquid is solidifi but in the case of the other molecule the two inte Raman lines 638 cm^{-1} and 786 cm^{-1} disappear w solidification of the liquid. A new Raman l 13 cm^{-1} appears with solidification of 1, 1, 1- chloroethane and a similar new line 60 cm^{-1} was a observed in the case of the other substance in the so state. Some of the Raman lines due to the t liquids are totally depolarized. The significance these results is discussed.

535.375.5 : 535.343-

3326. The assignments of the Raman and infra frequencies of 1,2-dichloroethane observed in gaseous, liquid, and solid states. I. Nakagawa a S. Mizushima. *J. chem. Phys.*, **21**, 2195–8 (*D* 1953).

Based on the normal vibration calculation of *trans* and the *gauche* molecules of 1,2-dichloroeth

s an eight-body problem, the assignments of the aman and infrared frequencies of this substance bserved in the gaseous, liquid and solid states have een made. The vibrational modes of these frequencies re discussed. A.

535.375.5 : 535.343–15

3327. An experimental study of the vibrational spectra of hexamethyldisilane and related compounds. C. C. CERATO, J. L. LAUER AND H. C. BEACHELL. *J. chem. Phys.*, **22,** 1–5 (*Jan.*, 1954).

Raman and infrared spectra have been obtained for trimethylphenylsilane, hexamethyldisilylmethylene, hexamethyldisiloxane, hexamethyldisilazine and hexamethyldisilane. For the last compound the infrared spectral region covered extended from 1–50 μ; for the other compounds the region extended only from 1–15 μ. The intensities and depolarization factors of the Raman bands were determined photoelectrically. A few tentative frequency assignments have been given. A.

535.375.5 : 539.132

3328. Origin of some peculiarities in the Raman spectra of substances with hydrogen bonds. SH. SH. RASKIN AND A. V. SECHKAREV. *Dokl. Akad. Nauk SSSR*, **86,** *No.* 2, 277–80 (1952) *In Russian.*

A continuation of previous work, in which 17 lines were found in the Raman spectrum of solid benzoic acid between 2500 and 3300 cm^{-1}, which have been thought by others to be caused by vibrations in the hydrogen bond. Nine of these lines have now been found in the liquid acid, and similar lines in the spectra given by various benzoic acid derivatives (esters, benzoyl chloride, etc.) not containing the OH group. The argument that these lines may be due to overtones of intramolecular deformational vibrations in the side chain is supported by some semi-empirical calculations about lines occurring at ~ 50 cm^{-1} in all these compounds. R. C. MURRAY

535.375.5 : 539.132

3329. A spectroscopic method of investigating the association of molecules of some organic compounds in different phase states. SH. SH. RASKIN AND A. V. SECHKAREV. *Dokl. Akad. Nauk SSSR*, **86,** *No.* 3, 509–12 (1952) *In Russian.*

See also preceding abstract. Tabulates data obtained for the Raman spectra of the benzoic, phenylacetic and hydrocinnamic acid, in crystal state and in a melt (at 2 temperatures). It has been found that a number of intramolecular lines observed in crystals are transformed at the melting-point into diffuse bands the maxima of whose intensity shift (usually toward longer wavelengths) as the temperature rises. These frequency shifts are explained by assuming the existence in crystals of complete molecular dimers that gradually dissociate in melts. Values calculated from Halford's paper [Abstr. 2981 (1946)] for two frequencies of the molecular deformation of benzoic acid show good agreement with experimental values. F. LACHMAN

535.375.54

3330. Low-frequency Raman spectra of some organic crystals. A. V. KORSHUNOV. *Dokl. Akad. Nauk SSSR*, **86,** *No.* 2, 271–2 (1952) *In Russian.*

The relative intensities measured for various low-frequency lines (and bands) of bromoform, at −5 and −35°c, acenaphthene, 1 : 3 : 5-trichlorobenzene, *o*-chloronitrobenzene, *p*-bromotoluene and 1 : 3 : 5-xylenol are tabulated. Most of the lines are fairly sharp. There is a change of spectrum for bromoform between −5 and −35°c, indicating a change of crystalline form around −20°c. R. C. MURRAY

535.375.55

3331. On the Raman spectra of solutions of 1, 2, 3-trichloropropane. T. A. HARIHARAN. *Indian J. Phys.*, **27,** 323–7 (*June*, 1953).

Solutions in methyl alcohol, cyclohexane and dioxane were investigated and microphotometric records of the spectrograms are reproduced. It was found that the line 872 cm^{-1} of 1, 2, 3-trichloropropane diminishes in intensity greatly when the liquid was dissolved in dioxane. In the case of the solution in methyl alcohol the intensity of the line also seems to be slightly smaller than that in the case of the pure liquid. In the case of the solution in cyclohexane no such changes in intensity were observed. The line 83 cm^{-1} also diminished in intensity with dissolution of the substance in dioxane. In the case of *o*-chlorotoluene the intensity of the line 164 cm^{-1} was found to diminish appreciably when the liquid was dissolved in benzene to make a dilute solution but no such diminution was observed in the case of solutions in either acetone or methyl alcohol. A.

535.375.56

3332. Raman spectra of chlorofluoromethanes in the gaseous state. H. H. CLAASSEN. *J. chem. Phys.*, **22,** 50–2 (*Jan.*, 1954).

Raman spectra of gaseous CCl_4, CCl_3F, CCl_2F_2, $CClF_3$, and CF_4 are presented in the form of microphotometer traces. All but one of the fundamental frequencies of these molecules have been observed. A.

535.376

3333. On the mechanism of electroluminescence. II. Applications to the experimental facts. D. CURIE. *J. Phys. Radium*, **14,** 672–86 (*Dec.*, 1953) *In French.*

Experimental effects described by various authors are interpreted by the mechanism proposed in Pt I [Abstr. 1204 (1954)]. The effects include (1) the influence of temp., producing a max. of electroluminescence at ~50–100°c with a decrease above this temp. similar to thermal extinction in normal luminescence, and a sharp rise at still higher temps. involving thermal activation; (2) the shape of the brightness waves, especially the secondary maxima sometimes observed; (3) the departures from a linear relation between frequency and brightness; and (4) the surface effects arising from barrier layers, including the in-phase component at high voltages [Abstr. 7195 (1952)]. Preparative details are briefly mentioned. The field emission theory of electroluminescence is rejected since it requires higher fields than those used in practice, and the theory of charge injection at *p–n* junctions is also considered inadequate because it cannot explain electroluminescence as a volume effect. S. T. HENDERSON

535.376 : 548.7

Nature of activators in quartz. *See Abstr.* 3994

535.39

3334. On achromatizing of two and three thin films. A. VAŠÍČEK. *Czech. J. Phys.*, **2**, 71–83 (1953).

The approximate formulae are deduced for the computations of two and three thin achromatized anti-reflecting films on a glass surface. The accuracy of these computations is quite satisfactory for optical practice, as is seen from the reflectances calculated according to exact formulae. A.

535.41 : 539.37

3335. The determination of strain by mechanical interference. J. KACZÉR AND F. KROUPA. *Czechoslovak J. Phys.*, **1**, *No.* 2, 80–5 (1952).

If two thin transparent plates having a lattice consisting of a set of equidistant parallel lines ruled on them be placed in contact and one plate be deformed, then on looking at them by reflected or transmitted light a fringe pattern analogous to an interference pattern can be seen. From measurements on this pattern the strain in the deformed plate can be found. The light may be convergent, divergent or parallel. The lattice may be linear, having between 100 and 200 lines per mm or curved; the ratio of line width to interval width is best 1 : 1. This system can be used as a lattice strain gauge both on models and original structures simply by cementing a lattice on the surface under test, placing another lattice in contact and observing the pattern in reflected light. The necessary theory is given and photographs show the application of the method. It is suggested that this method could replace or supplement conventional photoelastic and electric strain gauge methods.

H. G. JERRARD

535.417

3336. Use of multilayer films for surface topography interferometry. J. A. BELK, S. TOLANSKY AND D. TURNBULL. *J. Opt. Soc. Amer.*, **44**, 5–10 (*Jan.*, 1954).

An experimental study is made of the suitability of multilayer reflecting films of zinc sulphide and cryolite for the examination of surface topography by multiple-beam interferometry. It is shown that the low absorptions of the films lead to fringe definition for reflection fringes, much superior to that given by silver of corresponding reflectivity. The wavelength selectivity of second-order films is made use of for viewing the surface detail through the matching flat by changing to a wavelength region wherein the multifilm is transparent. It is shown how the wavelength characteristics can rapidly be assessed with white light fringes of equal chromatic order. The good contouring properties of the multilayers are established experimentally, and there is close contouring at least down to steps of 90 Å in height. An application to vibrational studies is indicated. It is considered that the multilayers have considerable advantages for studying opaque surfaces. A.

535.417

3337. A new method in optical interferometry. K. M. BAIRD. *J. Opt. Soc. Amer.*, **44**, 11–13 (*Jan.*, 1954).

A new, rapid and accurate method for obtaining the order of interference in a Fabry–Perot etalon is discussed. Apparatus for using the method in calibrating end standards is described. Possible improvements and application to other measurements s as wavelength determinations are pointed out.

535.417 : 5

Theory of Michelson's stellar interferometer. *Abstr.* 3021

535.417 : 531.74 : 539

3338. Interferometric measurement of grain boun grooves. S. AMELINCKX, N. F. BINNENDIJK AND DEKEYSER. *Physica*, **19**, 1173–7 (*Dec.*, 1953).

Attention is drawn to the possibility of u multiple-beam interferometry for measurements the dihedral angle of the groove between grains polycrystalline metal aggregate. Two methods found to work satisfactorily. The first consist matching a silvered optically flat glass surface aga the metal surface. The use of monochromatic l results in the formation of Fizeau-fringes. W white light is used, a profile of the groove can obtained from the fringes formed in the focal pl of a spectrograph. The second method uses interferometer which consists of the metal surf and a silver layer, both components being separa by a thin sheet of mica. Using white light and p jecting the image of the surface on the slit of a spec graph, allows to obtain fringes of equal chrom order, from the shape of which the profile of groove can be deduced.

535.42 : 534.32

3339. Diffraction of light by superposed ultrasc waves—a theoretical study. J. SATYANARAYANA MUR Letter in *Curr. Sci.*, **22**, 299–300 (*Oct.*, 1953).

Gives expressions for diffraction by waves frequencies in any integral ratio. G. F. LOTH

535

3340. Optical properties of carbon particles. RÖSSLER. *Optik*, **10**, *No.* 11, 531–53 (1953) *In Germa*

The theory of optical scattering is reviewed a formulae developed for the extinction coefficients to scattering (K_S) and absorption (K_A) as a functi of wavelength (λ), particle radius (r) and no. particles per cm^3. (N). Calculations are made carbon and curves give $K_S/N\pi r^2$ and $K_A/N\pi r^2$ agai r/λ; also, for $\lambda = 600$ mμ, K_S/N, K_A/N, $K_S f(r)$ and $K_A f(r)/N$ against r, where $f(r)$ is a Gauss distribution function for carbon particles in a Hefi burner, where $r_{mean} \simeq 12{\cdot}5$ mμ. The results c be used to determine the concentration of C in flame from optical measurements. 27 refs.

G. F. LOTHI

535

3341. New computation of the Mie scattering fu tions for spherical particles. B. GOLDBERG. Letter *J. Opt. Soc. Amer.*, **43**, 1221–2 (*Dec.*, 1953).

Total scattering coefficients have been calculat for water at close intervals up to $2\pi r/\lambda = 30$.

G. F. LOTHI

535.

3342. Theoretical light-scattering coefficients relative refractive indexes less than unity and totally reflecting spheres. R. H. BOLL, R. GUMPRECHT AND C. M. SLIEPCEVICH. *J. Opt. So Amer.*, **44**, 18–22 (*Jan.*, 1954).

Theoretical light-scattering coefficients, $K_t(m,$ for spherical particles have been computed for valu

f m of 0·8, 0·9, and 0·93, where m is the ratio of the index of refraction of the particle with respect to the surrounding medium. Values of α (circumference of the particle divided by the wavelength of the incident beam) range from 1 to 200. The coefficients, $K_t(m,\alpha)$, may be reduced to a single curve, $K_t(L')$, by means of the Lorenz–Lorentz relation which facilitates interpolation for values of m between 0·8 and 0·93. The $K_t(L')$ curve has a shape similar to the corresponding curve for ratios of refractive indices greater than unity, but the primary peak is significantly lower. For totally reflecting spheres ($m = \infty$) the value of K_t in the range of α between 1 and 90 oscillates about a value of $K_t = 2{\cdot}10$ ($\pm$ 5%). The coefficients were calculated and checked by high-speed computers. A.

535.434

3343. Contributions to the theory of the optics of white sols. I. Influence of polydispersivity on the turbidity of white sols with spherical particles. F. Evva. *Z. phys. Chem.*, **202,** 208–20 (*Oct.*, 1953) *In German.*

Turbidity $= Er^2\pi N$, where E = scattering area coefficient, r = particle radius and N = no. of particles per cm^3 of suspension. Expressions are developed from which the effective value of E for a polydisperse suspension may be computed from the known values for uniform suspensions. Gaussian, log-normal and exponential distribution functions are considered. Some typical cases have been computed and are illustrated by curves.

G. F. LOTHIAN

535.434

3344. Scattering of light in sols of orientated particles. C. Wippler. *J. Phys. Radium*, **14,** 65 S–66 S (*Dec.*, 1953) *In French.*

The phenomenon is explained by destructive interference of the wavelets scattered by different points of the particle. An expression for the intensity of the light scattered by elongated particles is given. This is stated to have been verified by experiments on stearic acid, vanadium pentoxide and tobacco mosaic virus. H. G. JERRARD

535.434 : 771.533

3345. The application of radiative transfer theory to scattering effects in unexposed photographic emulsions. E. Pitts. *Proc. Phys. Soc.* [*London*] *B*, **67,** 105–19 (*Feb.*, 1954).

The general problem of the transmission of light through a medium containing many particles which both scatter and absorb light has been investigated. The derivation of the basic equation is briefly indicated, and methods for its solution described. Results are calculated for parallel light incident normal to the surface of a plane layer. The energy reflected and transmitted by the layer is found, and from this the energy absorbed is deduced. The effects of reflections at the interfaces are considered. These results are used to explain the apparent discrepancy between the observed optical density of an unexposed photographic emulsion layer and the result calculated by using the value of the absorption coefficient of the bulk silver halide, and neglecting all effects due to scattering. Other general results predicted by the full treatment of the problem are also shown to be in agreement with experiment. A.

535.435 : 536.48

Light scattering in liquid helium. *See Abstr.* 3384

535.515 : 539.37 : 539.216

Optical properties of cellulose fibres. *See Abstr.* 3899.

535.52

3346. Passage of rays of light through a crystalline plane-parallel plate. Kh. Ya. Khristov. *Dokl. Akad. Nauk SSSR*, **85,** *No.* 6, 1269–72 (1952) *In Russian.*

Derives an approximate solution for the system of linear equations characterizing the passage of a normally incident electromagnetic wave through a plane-parallel plate of an orthorhombic crystal with a dipole in every crystal unit cell, when the incident wave is polarized in the direction of one of the crystallographic axes and its length is large compared with the dimensions of the unit cell. [See also Abstr. 5926, 7313 (1952).] F. LACHMAN

535.55 : 532.51

3347. The flow birefringence of concentrated solutions of linear macromolecules. A. Peterlin. Letter in *Bull. sci. Cons. Acad. Yougoslavie*, **1,** 40–1 (*July*, 1953) *In French.*

The linear relationships existing between viscosity, flow birefringence and velocity gradients in the case of dilute solutions fail as the concentrations increase. This is due to the increased interaction effects of the macromolecules. To explain this the viscosity of the solvent, which is usually considered to be the decisive factor in flow, is replaced by an effective viscosity η^* defined by the equation $\eta^* = (\eta - \eta_e)/c(\eta)$, where η and η_e are the viscosities of the solution and solvent respectively, (η) is the intrinsic viscosity and c the concentration. Using this concept some of the orientation effects found in the flow of concentrated solutions are explained. H. G. JERRARD

535.55–15

3348. Photo-elastic stress analysis in the infra-red region of the spectrum. F. Kroupa. Letter in *Czech. J. Phys.*, **1,** *No.* 3–4, 205–6 (1952).

Details are given of some photoelastic investigations in the i.r. Photographs illustrate some of the results. In this spectral region ebonite can be used for models: it has a photoelastic constant of 25 brewsters.

H. G. JERRARD

535.65

3349. A determination of subjective white under four conditions of adaptation. W. N. Sproson. *B.B.C. Quart.*, **8,** *No.* 3, 176–92 (1953).

Experiments are described to find out by statistical observation the area on the chromaticity diagram which is accepted as white and to determine how the result is affected by the type of adaptation with and without immediate surround adaptation. The experiments were conducted in two groups: a tricolorimeter with three projectors and primary colour filters and an additional projector providing a surround field (approx. three times the area of the screen with one-tenth illumination) placed to the disposal of the colour-normal observers who adjusted the luminance of the three colours until "white" was

obtained, was used in the 1st method. The 2nd method relied on the individual subjective determination of the succession of colours which are in the neighbourhood of the white point, and a single projector with a 250 watt lamp and a series of filters of desaturated green and magenta colour are used. Both methods and the apparatus employed and their setup and calibration are described in detail, and the results are shown in numerous curves and tables. An equation for the recommended "white" is quoted. The conclusions show that the above results do not agree entirely with previous American investigations.

A. LANDMAN

535.7 : 612.84

Physiological optics. *See Abstr.* 4061–5

535.81 : 621.317.755 : 621.396.963

3350. An experimental determination of signal discernibility enhancement by two raster-type CRT displays. W. O. GARRETT, R. L. YOUNG AND R. C. FERRIS. *J. Opt. Soc. Amer.*, **44**, 80–4 (*Jan.*, 1954).

A raster-type c.r.t. display has been investigated as a means of improving the visual detection of weak radar signals. Two raster displays of different sizes were compared with a single-trace display under two conditions of screen brightness and signal-noise levels. The smaller of the two rasters was found to give significantly lower detection thresholds; its greatest superiority is shown, however, at the lower signal-noise and brightness levels. A.

535.822.17 : 535.826

3351. Phase microscopy of razor blades. S. YAMAGUCHI. Note in *Naturwissenschaften*, **41**, *No.* 1, 16 (1954) *In German.*

The use of a phase microscope to test razor blades used in optical experiments is suggested. Two sample photographs showing typical fringe patterns are included. R. W. FISH

535.833

3352. Anallactic telescopes. H. SCHULZ. *Optik*, **10**, *No.* 11, 564–6 (1953) *In German.*

The author shows that with a three-lens system it is possible to make a truly anallactic telescope focusing from infinity to 1 metre. Equations governing the focal lengths and separations are given and one solution convenient in practice is obtained.

R. W. FISH

535.833

3353. A large range variable magnification telescope. F. G. BACK. *J. Opt. Soc. Amer.*, **43**, 1195–9 (*Dec.*, 1953).

Telescopes which allow a change of magnification of 3 to 1 linear or 10 to 1 in area are well known. A new telescopic system with variable magnification is described which has a range of angular magnification of 10 to 1 or a variation of area covered of 100 to 1. The apparent angle of field is 53°. During the changes in magnification the focal deviation is negligibly small and well within the accommodation range of the human eye. A.

535.833

3354. Analysis of Cassegrainian-type telescopic systems. P. R. YODER, JR, F. B. PATRICK AND A. E. GEE. *J. Opt. Soc. Amer.*, **43**, 1200–4 (*Dec.*, 1953).

Several modifications of the Cassegrainian-type telescopic system using a spherical secondary mir are discussed in terms of the effect of such modifi tions on the image quality at moderate apertures focal lengths. Both third-order and trigonome methods are used to compare the various systems. is found that an *f*/11 true Cassegrainian system effective focal length 130 in. gives excellent im rendition over a field of approximately 1·7°, whi more easily manufactured modified system of the sa optical dimensions using a spherical secondary mir and an ellipsoidal primary mirror gives equival image rendition over a field of approximately 0·42

535.

3355. A design for a wire grating. E. LEIBHAR Letter in *J. Opt. Soc. Amer.*, **43**, 1221 (*Dec.*, 1953)

Practical details (with 3 explanatory figures) given for the construction of a precision-made w grating suitable for use in the near-focus converg beam of a long-focus refracting telescope.

D. R. BAR

535

3356. A light collector, which acts on the princi of superposition, and is applicable to sources of sm dimensions. K. TOISHI. *J. Sci. Res. Inst.* [*Tokyo*] 8–14 (*March*, 1952).

A prism arrangement is described which allows brightness of a light source to be increased by multi reflection. Calculation shows that increases up 9× are possible with transparent sources. Appli tions to spectroscopy are briefly discussed. R. W. F

535

3357. A comparison of sources giving continu u.v. spectra. G. J. ULLRICH. *Z. angew. Phys.*, *No.* 9, 350–1 (1953) *In German.*

A brief comparison of some of the luminous char teristics of various sources, namely h.p. xenon lam underwater sparks, hydrogen lamp, carbon arcs a tungsten lamps. J. D. CRA

535.89 : 537.523.5 : 621.325.1

3358. A fully automatic continually operating, v high-intensity, carbon arc lamp. W. FINKELNBU AND J. P. LATIL. *J. Opt. Soc. Amer.*, **44**, 1–5 (*Ja* 1954).

A 200 A 80 V fully automatic carbon arc lamp described which is capable of operating unint ruptedly for many hours at a time. The peak brig ness of the positive crater is over 1600 candles square millimetre, its average brightness appro mately 1200 candles per mm², with averaged brig ness variations of only ±3%. The total radiati density of the crater in watts per cm is equal to th of a black body of approximately 5400°K, whereas t spectral energy distribution of the visible radiati resembles that of a black body of approximate 7000°K. The arc, of 18 mm length, is operat between the rim of a negative graphite disk of 20 initial diameter and the positive crater of a wat cooled 11 mm super-high-intensity carbon which consumed at the rate of approximately 40 in. hour. Fine air streams protect the water-containi positive metal jaws from flashbacks of the arc. positive magazine mechanism was developed by whi

utomatically one positive carbon is joined to the next ne, thus enabling the arc to operate uninterruptedly. eeding of the positive carbon and rotation of the egative disk are triggered by the arc itself by means f electric probes. The new lamp may be used herever a reliable automatic source of very high rightness, high-total radiant emittance, and high emperature is required. A.

HEAT 536

536.2 : 536.3 : 537.39

3359. The distribution of temperature along a thin od electrically heated *in vacuo*. I. Theoretical. S. C. AIN AND K. S. KRISHNAN. *Proc. Roy. Soc. A*, **222**, 167–80 (*March* 9, 1954).

The distribution is determined uniquely by three parameters, namely, (1) the temperature at the centre of the rod, (2) that at the centre of a similar infinitely long rod heated by the same current, and (3) a simple constant that involves directly the cross-section of the rod, its thermal conductivity and the emissivity of its surface. Though the integral that determines the temperature distribution cannot be evaluated directly, it is shown that it can be expanded as a convergent power series. The rod may be divided for this purpose into two well-defined regions, region *A* comprising a certain length in the middle of the rod, and region *B* consisting of the portions outside *A*, the appropriate series for the evaluation of the integral being different in the two regions. The temperature coefficients of the physical constants involved can also be taken into account in the evaluation. The temperature distribution in the *A*-region is found to be parabolic. Hence when the rod is too short to have any *B*-region at all, the theoretical relations become particularly simple, and are also practically independent of the finite temperature coefficients of the physical constants involved. The distribution in the *B*-region is found to be practically the same as in the corresponding end-portions of an infinitely long rod, except near the upper limit of the *B*-region when this region is very short. An analytical expression is also obtained for the temperature at the centre of the rod as a function of its length. The criterion for the validity of the well-known logarithmic formula for temperature distribution is shown to be much less stringent than is generally taken to be; the range of its applicability is thus extended far into the *B*-region even when the rod is not long. The additive constant in the formula, which previously had to be left undetermined, also gets evaluated now. A.

536.212 : 537.311.33

The estimation of the thermal conductivity of semiconductors. *See Abstr.* 3476

536.212.2 : 537.312.62

Thermal conductivity of superconductors. *See Abstr.* 3507–8

536.23

3360. Abnormal heat conductivity of gaseous hydrogen fluoride. E. U. FRANCK AND W. SPALTHOFF. Note in *Naturwissenschaften*, **40**, *No.* 22, 580 (1953) *In German.*

The heat conductivity of gaseous HF was measured in the temperature range from −5·5 to 222°c at pressures 25–500 mm Hg. The pressure dependence of the very high λ values (approximating those for non-metallic liquids) can be represented fairly accurately for lower temperatures (−5·5 and 3·5°c) by assuming $6HF \rightleftharpoons (HF)_6$, with an association enthalpy of 41 kcal/mole $(HF)_6$ [Long, Hildebrand and Morell, *J. Amer. Chem. Soc.*, **66**, 182 (1943); also Simons and Hildebrand, *ibid.* **46**, 2183 (1924)]. For higher temperatures, the mechanism $6HF \rightleftharpoons (HF)_6$ does not yield satisfactory results. F. LACHMAN

536.23

3361. Conduction of heat in highly compressed gases. E. U. FRANCK. *Chem.-Ingen.-Tech.*, **25**, 238–44 (*May*, 1953) *In German.*

Graphs, in the form of smoothed isobars or isotherms, the available data for A, He, H_2, air, N_2, O_2, CH_4, C_2H_4, CO_2, H_2O, C_6H_6, $C_6H_5CH_3$, $C_6H_4(CH_3)_2$. Suggests a new approximate equation, relating the effect of pressure on heat conductivity with that of pressure on the specific volume and specific heat, and evaluates, with its aid, the heat conductivity of gaseous NH_3 at pressures up to 60 kg/cm² and temperatures up to 150°c. 33 refs. F. LACHMAN

536.24 : 533.6.011.6

3362. On the Nusselt modulus as a function of friction factor, Reynolds and Prandtl moduli, for heat transfer to a fluid flowing turbulently through a tube of circular section. A. W. MARRIS. *Canad. J. Phys.*, **32**, 167–89 (*Feb.*, 1954).

Theoretical expressions for the Nusselt modulus and radial temperature distribution in terms of Reynolds number, Prandtl number, the ratio k of the eddy diffusivities for heat and momentum, and the friction factor are developed for the case of heat transfer from a tube of circular section to a fluid flowing turbulently through it. The results, appropriate to fluids with Prandtl numbers greater than $1/2k$, are derived on the assumption of the constancy of fluid properties and require a linear longitudinal temperature gradient in the tube itself. They enable the effect of the insulating "laminar" and "buffer" layers adjacent to the tube wall to be demonstrated at various Prandtl numbers and are appropriate for correlation with experiment for the investigation of the constancy or otherwise of the ratio of the eddy diffusivities for heat and momentum implicit in the momentum transfer analogy. A similar result is worked out on the vorticity transfer analogy for the particular case of Prandtl number equal to $1/k'$ and is found to be invalid for such a configuration. Here k' is the ratio of the eddy diffusivities for heat and vorticity. A.

536.24 : 533.6.011.6

3363. An experimental investigation of the heat transfer to turbulently flowing pressurized air. A. W. MARRIS. *Canad. J. Phys.*, **32**, 190–200 (*Feb.*, 1954).

Employing a counter-flow figure-of-eight heat exchanger, direct measurements are made of the Nusselt modulus for radial heat transfer to air pressurized up to 20 atmospheres for Reynolds numbers up to $1{\cdot}20\times10^5$. For each heat transfer determination a simultaneous friction factor measurement is made and it is found that the latter is independent of heat transfer. Results in reasonable

agreement with the momentum transfer theory are obtained for Reynolds numbers less than $0{\cdot}75\times10^5$, provided the ratio of the eddy diffusivities for heat and momentum is taken as unity. For such values of the Reynolds number, the same value of the heat transfer coefficient was obtained irrespective of whether the Reynolds number was obtained by having high pressure (density) and low velocity, or high velocity and low pressure. For higher values of the Reynolds number, however, the value of the heat transfer coefficient appeared to become dependent on the over-all heat transfer rate.

536.24 : 621.3.017.7

3364. The determination of favourable forms of surface for the removal of electrical heat loss. A. RAESFELD. *Siemens-Z.*, **27,** 375–9 (*Nov.*, 1953) *In German.*

The quality of heat-exchange surfaces is discussed in terms of a performance factor ε [H. Glaser, *Z. angew. Chemie*, **20,** 129–33 (1948)] which depends on the surface area H and the properties of the cooling fluid. The particular cases of external laminar flow and turbulent flow in a round tube and cross-sectional flow across a bundle of wires are considered and formulae derived for ε and H. The relationships between ε and H are shown graphically. In other cases the dependence of the heat transfer coefficient and the pressure fall on the fluid velocity must be known. Results for a ribbed surface are shown graphically. S. WEINTROUB

536.42 : 536.75

3365. Entropy of melting and the course of the cryometric curve. Y. DOUCET. *C.R. Acad. Sci.* [*Paris*] **237,** 1688–90 (*Dec.* 21, 1953) *In French.*

The tangent at the origin to the curve of molecular depression against concentration has a positive slope if the molecular entropy of fusion of the non-dissociating solvent is greater than 4 cal deg^{-1}. For compounds with spherical symmetry the slope is negative if the entropy of fusion is less than 4 cal deg^{-1}. For a solvent totally dissociated the sign of the slope depends, in a simple case, on the ratio of the numbers of ions of solute and solvent.

F. E. HOARE

536.421.1

3366. Theory of local fusion. I. M. LIFSHITS AND L. S. GULIDA. *Dokl. Akad. Nauk SSSR*, **87,** *No.* 3, 377–80 (1952) *In Russian.*

Mathematical analysis of the thermodynamic potentials of an isotropic solid phase with disseminated liquid nuclei. It is assumed that no substantial correlation exists between the nuclei. The results of the analysis help to explain the experiments of S. É. Khaikin and N. P. Bine [*Dokl. Akad. Nauk SSSR*, **23,** *No.* 1 (1939)] who observed (1) in polycrystalline Sn samples a process of fusion beginning inside the solid phase, and (2) a superheating of 1·5–2°c in Sn monocrystals. F. LACHMAN

536.421.1

3367. Development of the nuclei of local fusion. L. S. GULIDA AND I. M. LIFSHITS. *Dokl. Akad. Nauk SSSR*, **87,** *No.* 4, 523–6 (1952) *In Russian.*

See preceding abstract. An analysis is given of thermodynamic potentials of the solid phase w progressed local fusion so that the dimensions of liquid-phase foci are comparable with the avera distances between the foci. At constant extern pressure, local fusion has been found to begin wh the solid phase is superheated. At the constan volume conditions local fusion begins at temper tures below those of the normal fusion. F. LACHM

536.42

3368. $BaTiO_3$-KF phase diagram. C. KARAN A B. J. SKINNER. Letter in *J. chem. Phys.*, **21,** 22 (*Dec.*, 1953).

This was obtained using the technique of different thermal analysis. There is no evidence of compou formation during the run of thermal analysis.

F. LACHM

536.4

3369. Mass spectrometric study of the molecul sublimation of graphite. R. E. HONIG. *J. chem. Phy* **22,** 126–31 (*Jan.*, 1954).

The emission of neutral and charged carb molecules from spectroscopically pure graphite w studied by rate of vaporization experiments in 180° mass spectrometer. Small filaments (di meter: 0·015 in.), heated by a.c. up to 2600° yielded neutral particles which were converted in positive ions by bombardment with low-energy ele trons. C_3^+, C_2^+ and C_1^+ ions were found. Althou the effects of fragmentation and of differences ionization cross-sections may not be negligible, it believed that carbon vapour consists largely of C molecules. Graphite was found to emit negati ions containing from one to eight carbon atom C_2^-, C_4^- and C_3^- were the most abundant species, that order. A search was made for carbon particl emitted as positive ions, but none were found. Hea of activation were obtained for the neutrals and th more abundant negative ions from the slopes log p *v.* $1/T$ plots. Identical heats measured fo C_1 and C_3 (178 ± 10 kcal/mole at 2400°K) sugge that these two species may sublime at rates that a interdependent. Thus, this value may not be repr sentative of the true heat of sublimation of C_1. F C_2, a heat of 199 ± 20 kcal/mole was measured 2400°K. Electron affinities have been computed fo C_1, C_2 and C_3, and estimated bond energies deduce for C_2 and C_3. Some of the earlier measurements the heat of sublimation of graphite, obtained fro rates of vaporization and equilibrium effusion, b without mass analysis, have been re-interprete taking into account the complex character of th sublimation processes.

536.423

3370. Dynamics of evaporation of liquid mixture obeying Raoult's law. L. I. RUBINSHTEĬN. *Dok Akad. Nauk SSSR*, **87,** *No.* 3, 357–60 (1952) *Russian.*

Parametric equations are derived for the variatio of the depth and density of an evaporating mult component solution, without making any of the usu simplifying assumptions and making use of th "kinetic coeff." β in a form derived by Leibenson [*Is Akad. Nauk, SSSR, Ser Geogr. and Geofiz.*, *No.* (1940)] from the study of a pure liquid. R. C. MURRA

536.423.1

3371. On the dynamics of evaporation of ideal multi-component liquid mixtures. L. I. RUBINSHTEĬN. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 6, 987–90 (1953) *In Russian*. English translation, *U.S. National Sci. Found. NSF-tr*-129.

Evaporation is supposed to take place from a finite area σ in the (x, y) plane into the entire half-space $z > 0$, the remainder of the (x, y) plane being a solid surface. Under the assumptions that (*a*) vapour propagation in an open atmosphere is by diffusion only; (*b*) the space-uniformity of the liquid-phase is preserved in time; (*c*) the thickness of the evaporating layer is small compared with the linear dimensions of σ, the problem reduces formally to one in the theory of heat-conduction with composite boundary conditions. This is attacked by the introduction of the appropriate Green's function, which leads to a system of functional equations which can be solved by successive approximations. This system is linear if the solvent is non-volatile and the solution is dilute.

A. J. TAYLOR

536.424 : 539.23 : 539.27

3372. Phase changes with changing thickness of thin metal films. A. I. BUBLIK AND B. YA. PINES. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 2, 215–18 (1952) *In Russian*.

Thin evaporated pure metal films of Be, V, Cr, Ni and Co were studied by electron diffraction. Lattice structure depends on thickness (t). All films with $t \geqslant 10^{-6}$ cm have a structure corresponding to the phase stable in bulk metal at room temperature. For $t < 10^{-6}$ cm new phases appear. Be film, $t = 5 - 6 \times 10^{-7}$cm, shows both α- and β-structure (β- not stable in bulk at room temperature), and at $t = 2 - 3 \times 10^{-7}$ cm β–Be only is observed. V film, $t = 6 - 7 \times 10^{-7}$ cm, has f.c.c. structure, $a_0 = 3{\cdot}82$ Å (unknown in bulk). Cr film, $t = 7 - 8 \times 10^{-7}$ cm, has b.c.c. structure, but at $t = 4 - 5 \times 10^{-7}$ cm, the structure is complex cubic (like α–Mn). Ni film, $t > 5 - 6 \times 10^{-7}$ cm, f.c.c. (β–Ni); $t = 4 - 5 \times 10^{-7}$ cm, f.c.c. (β–Ni) and also hexagonal (α–Ni); $t = 2 - 3 \times 10^{-7}$ cm, α–Ni only. These results are explained by assuming an additional term in free energy $\Omega = 2\sigma + \Sigma w_i \sigma_{ik}$, σ = surface energy metal-vacuum, σ_{ik} = surface energy metal–metal, w_{ik} = intergranular contact area. This term becomes important when films are very thin, and may give a phase, normally unstable at room temperature, the lower free energy. Estimates of grain size from breadth of diffraction rings give reasonable quantitative agreement with observed critical thickness for phase change.

J. W. MENTER

536.44

3373. An additive function of critical constants. S. S. MITRA. Letter in *J. chem. Phys.*, **21**, 2234 (*Dec.*, 1953).

For the homologous series of normal paraffins (methane to nonadecane) the function $K = 100\, n/\log(T_c^2/P_c)$ is additive, n being the number of carbon atoms. Existing data are found to fit (with an error of $< 1\%$ except for the first five members) the formula $K_n = 32{\cdot}77 + 20{\cdot}06\, n$.

W. GOOD

536.44

3374. Critical temperature and boiling point of normal paraffins. Y. P. VARSHNI. Letter in *J. chem. Phys.*, **21**, 2235 (*Dec.*, 1953).

For the homologous series, methane to nonadecane, the crit. temp. and boiling point are related by the equation $1/T_c = 0{\cdot}5405/T_b + 0{\cdot}0003937$. Using observed boiling point values T_c is calculated and agrees to within 1% with the observed values.

W. GOOD

536.44

3375. Critical constants of normal paraffins. Y. P. VARSHNI. Note in *Naturwissenschaften*, **41**, *No.* 1, 12–13 (1954).

The formula $T_c^3 = 8101{\cdot}3 \times 10^6/P_c - 141{\cdot}14 \times 10^6$ (T_c in °K, P_c in atm.) is suggested. The values of P_c, calculated from the experimental T_c values, differ from the experimental T_c values, differ from the experimental P_c by $\sim \pm 2{\cdot}5\%$ for C_nH_{2n+2} ($n = 2 \ldots 19$), the discrepancy being $+19{\cdot}3\%$ for CH_4.

F. LACHMAN

536.46

3376. Flame zone studies by the particle track technique. I. Apparatus and technique. R. M. FRISTROM, W. H. AVERY, R. PRESCOTT AND A. MATTUCK. *J. chem. Phys.*, **22**, 106–9 (*Jan.*, 1954).

Discusses flame temperature profiles of laminar premixed Bunsen flames derived by the particle track method. The apparatus required for the study is described. A critical discussion of the technique and the flame model is presented. This method allows the derivation of a temperature profile for a flame front which is accurate in temperature and relative position to a few percent depending on the pressure. The profile should provide description of translational temperature within the flame front. The singular regions of the flame tip and burner lip are excluded from this discussion.

A.

536.461 : 541.126.2

3377. Flame propagation: the effect of pressure variation on burning velocities. A. EGERTON AND A. H. LEFEBVRE. *Proc. Roy. Soc. A*, **222**, 206–23 (*March* 9, 1954).

The burning velocity of mixtures of methane, propane, ethylene and propylene with air are determined under constant-pressure conditions in a tube of rectangular section at pressures from ½ to 9 atm. For methane and also for propane, the effect of mixture strength was also investigated. Schlieren photographs of the passage of the combustion wave were obtained. The conditions leading to vibrations and to turbulence in the flame front, and also to change in the shape of the surface of the advancing flame, were investigated. The burning velocity was obtained from measurements of the speed of uniform movement and the flame area. A special valve maintained communication with an atmosphere of nitrogen during passage of the flame so as to maintain the pressure constant. The results are compared with other measurements. The pressure exponent is about 0·5 for methane and for other gases approximately 0·3, but there is some variation with change of mixture strength; the richer mixtures are less affected by pressure. The results indicate that both heat and diffusion (particularly of hydrogen atoms) play a part in flame propagation.

A.

536.48 : 533.16

Measurements of the viscosity of He gas at liquid helium temperatures as a function of temperature and pressure. *See Abstr.* 3184

536.48 : 538.222

3378. The thermal and magnetic properties of chromium potassium alum below 0·1°K. J. M. Daniels and N. Kurti. *Proc. Roy. Soc. A*, **221**, 243–56 (*Jan.* 21, 1954).

An account is given of a determination of the entropy and absolute temperature as a function of "magnetic temperature" (i.e. the reciprocal of susceptibility) for chromium potassium alum in the temperature range 0·007 to 0·1°K. The Curie point, which is characterized by a λ-anomaly in the specific heat, and a maximum in the susceptibility, is found to be at 0·011°K for this substance. The results are discussed in the light of other previously published and contradictory measurements on this substance. A theoretical treatment of the influence of the crystalline electric field on the entropy of magnetization is given in an appendix. A.

536.48

3379. Recent Russian work on liquid helium. J. Wilks. *Nuovo Cimento*, **10**, *Suppl. No.* 4, 509–38 (1953).

A descriptive review with bibliography (106 refs.) of work done since 1941—the date of publication of Kapitsa's experiments on superfluidity and of Landau's theory. The Russian work since that date forms a remarkably coherent whole, and is discussed without reference to authors outside Russia except where really necessary.

536.48

3380. The structure of liquid helium. J. Reekie and T. S. Hutchison. Letter in *Phys. Rev.*, **92**, 827 (*Nov.* 1, 1953).

X-ray interference patterns of liquid helium at 2·06°K are evaluated in terms of a radial distribution function. This function has two maxima at 3·15 and 4·24 Å. The authors resolve the distribution in contributions of shells about these two radii. A third shell is assumed to correspond to a radius of 5·40 Å, in spite of the fact that at this distance the distribution function has a value below average. Results are interpreted in terms of a lattice structure of liquid helium so that superfluidity is regarded as a kind of gliding on slip planes. R. Eisenschitz

536.48

3381. Small angle X-ray scattering from liquid helium I and liquid helium II. A. G. Tweet. *Phys. Rev.*, **93**, 15–20 (*Jan.* 1, 1954).

X-rays from a rotating Cu anode X-ray tube have been scattered from liquid helium at angles up to 5 degrees in the temperature range from 1·5°K to 4·2°K. The helium was contained in a thin-walled aluminium tube enclosed in a metal cryostat with beryllium windows. The liquid structure factor obtained experimentally, agreed well with the theoretical zero-angle liquid structure factor between 3°K and 4·2°K. Below about 2°K, the observed value of the zero-angle structure factor is larger than the theoretical value by an amount believed to be outside the experimental error. Angular distributions at 4·2°K are typical of liquid scattering patterns near the critical point. No scattering anomaly was observed near the λ point. A

536.48

3382. The magnetic time constant of dilute solutions of He^3 in He^4. A. Akhiezer and V. Aleksin. *Dokl. Akad. Nauk, SSSR*, **92**, *No.* 2, 259–62 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-183.

Specifying the state of a He^3 nucleus by its momentum and spin component, the change in time of the nuclear distribution is regarded as a stochastic process. The time derivative of the distribution function (in absence of an external field) is expressed in terms of the equilibrium distribution and a transition probability; the latter is obtained by means of perturbation theory from the dipole interaction of the spins. A relaxation time, defined as the ratio of the magnetic moment of the solution and its time derivative, is then calculated in terms of the transition probability. In the low-temperature limit (Fermi statistics) the time constant is inversely proportional to the square of the absolute temperature, independent of the concentration and, at 1°K, approximately equal to 4 hours. In the high-temperature limit it $\propto 1/$(concentration and square root of temperature). R. Eisenschitz

536.48

3383. The vapor pressure curve of helium between 4·2°K and 4·8°K. R. D. Worley, M. W. Zemansky and H. A. Boorse. *Phys. Rev.*, **93**, 45–6 (*Jan.* 1, 1954).

Measurements of the resistance of four Allen-Bradley carbon resistors in the liquid helium temperature range from 1·8° to 4·2°K and at the hydrogen triple point have been fitted to smooth calibration curves. When the resistance is measured at helium vapour pressures from 760 mm to 1350 mm, and the corresponding temperatures are obtained from the so-called "agreed" scale of Van Dijk and Shoenberg, the calibration points in this range do not lie on these calibration curves. This discrepancy and the fact that the vapour pressure-temperature relation above 4·2°K has not been determined since 1915 suggests that a redetermination of the vapour pressure-temperature relation above 760 mm is desirable. A

536.48 : 535.43

3384. Light scattering in liquid helium. A. W. Lawson and L. Meyer. *Phys. Rev.*, **93**, 259–60 (*Jan.* 15, 1954).

Classical formulae appear to describe adequately the data reported here on the relative scattering of light by liquid and gaseous helium. Anomalous scattering at the λ-point, if present, is less than the relatively large experimental error of about 20%. A

536.48 : 536.65

3385. Heat of mixing of He^3 in He^4. H. S. Sommers, Jr, W. E. Keller and J. G. Dash. *Phys. Rev.*, **92**, 1345–6 (*Dec.* 15, 1953).

The integral heat of mixing for an 8·6% solution of He^3 in He^4 at 1·0°K, measured by an adiabatic free-expansion process, is 0·17 cal/mol. of solution

Combined with the free energy of mixing, obtained from vapour pressure data, this shows that at this temperature the bulk of the excess free energy of mixing is due to the heat of mixing. A.

536.48

3386. The critical velocity and frictions in the flow of liquid helium II. Damped oscillations in the surface film of liquid helium II. Gorter's friction and saturation of surface flow rate. T. KASUYA. Letters in *Progr. theor. Phys.*, **9**, 87–9, 89–90, 90–91 (*Jan.*, 1953).

In these 3 letters the expressions for volume friction $A(v_s-v_n)^3$ by Gorter and Mellink [Abstr. 6163 (1949)] and for surface friction Bv_s^3 suggested by Hung, Hunt and Winkel [Abstr. 2416 (1953)] are discussed with the additional assumption that these frictions set in suddenly above the critical velocity. The small damping of subcritical film flow oscillation observed by Atkins [Abstr. 8712 (1950)] is ascribed to the heat jump found by Kapiza at a heat source. H. LONDON

536.48

3387. Determination of the velocity of the second sound in helium II up to the temperature of 0·85°K. V. P. PESHKOV. *Zh. eksper. teor. Fiz.*, **23**, *No.* 6(12) 686–9 (1952) *In Russian.*

A description of an apparatus for obtaining low temperatures by pumping out helium vapour with an oil diffusion pump is given. This apparatus was used to measure the velocity of the second sound up to the temperature of 0·85°K, by the resonance method which was described previously [Abstr. 2474 (1949)]. The velocity increases from a minimum of 18·3 m/sec at 1·12°K to a maximum of 22·5 m/sec at 0·85°K. In the range from 200 to 5000 cycles at 1° and 0·9°K, the velocity of the second sound remains constant. The experiments carried out showed the preference of the resonance method as compared with the pulse method. By this method it was possible to determine the velocity more accurately, and also to establish the absence of dispersion in the region of ultrasonic frequencies. E. RABKIN

536.48

3388. Two fluid description of liquid helium II. S. KOIDE, N. MATSUDAIRA AND T. USUI. *Sci. Pap. Coll. Gen. Educ. Univ. Tokyo*, **2**, 129–44 (*Dec.*, 1952).

The main point of interest is the relation between the specific entropy s and the fraction of normal phase ξ. Absence of dispersion of second sound above 1°K indicates that $(\partial s/\partial \xi)_p$ is independent of T. ξ is calculated from $d\xi\{\xi(1-\xi)\}^{-1/2}=\{C_p/T\}^{1/2}dT/C_2$, where C_p = specific heat and C_2 = second sound velocity, and from the directly determined value of ξ of Andronikashvilli at 1·8°K. From this the partial specific entropy $s_s = s - \xi(\partial s/\partial \xi)_p$ is calculated and found to form a substantial fraction of s below 1·5°K, whereas the directly measured values of ξ of Andronikashvilli below 1·8°K agree better with the expression $\xi = s/s_\lambda$, which implies $s_s = 0$. $s_s \neq 0$ is believed to be the cause of the deviation between C_2 measurements and the formula $C_2^2 = Ts^2(1-\xi)/(\xi C_p)$ which appears when the authors' ξ values are used. This formula is based on $s_s = 0$. C_2 measurements with $He^4 - He^3$ mixtures evaluated on the basis of Taconis–Beenakker's theory of ideal mixing of He^3 with the normal He^4 fluid lead to the conclusion that He^3 does not participate in the second sound.

H. LONDON

536.48

3389. Second sound in He^3–He^4 mixtures below 1°K. J. C. KING AND H. A. FAIRBANK. *Phys. Rev.*, **93**, 21–7 (*Jan.* 1, 1954).

An investigation has been made of second sound in mixtures of He^3–He^4 in the temperature region obtained by demagnetization of a paramagnetic salt. Several concentrations of He^3 were used ranging between 0·0017% and 4·3% The velocity of second sound for the mixtures was found to reach a maximum value of about 35 metres/sec just below 1°K and to approach 20 metres/sec near 0·2°K. In addition, essentially no dispersion of second-sound pulses in mixture below 1°K was observed. This is in marked contrast to heat pulses in pure He^4 in this temperature region. The results show general agreement with the theoretical predictions of Pomeranchuk, provided the effective mass μ of the He^3 atom is allowed to vary from 2·0 m_3 at 0·2°K to 3·6 m_3 at 1·8°K. A.

536.48

3390. Second sound propagation below 1°K. D. DE KLERK, R. P. HUDSON AND J. R. PELLAM. *Phys. Rev.*, **93**, 28–37 (*Jan.* 1, 1954).

The pulse method has been employed to measure the velocity of second sound in liquid helium, u_2, in the temperature range 0·015°–1·0°K. The liquid helium was in thermal contact with a sample of chromic potassium alum and cooling was achieved by adiabatic demagnetization. In the region of 0·8°K, u_2 rises quite abruptly, reaching the Landau velocity of $u_1/\sqrt{3}$ by 0·5°K. Thereafter it continues to increase, but much less rapidly, with decreasing temperature. A further sharp rise was observed for low-energy pulses at about 0·05°K, suggesting an approach to the velocity of sound u_1 at absolute zero. In the phonon region below 0·5°K, the thermodynamic quantity ρ_n/ρ shows very nearly the fourth-power (actually 4·18) dependence on temperature predicted by Landau. Values for the roton contribution to the normal fluid concentration $(\rho_n)_{rot}/\rho$ agree very well with Landau's predictions, with a small adjustment of the constants in the theory. For the smallest pulses used, the distortion (or dispersion) is very small when the pulse temperature is smaller than the ambient value and large when the reverse is true. For larger pulses the spreading decreases very slowly as the temperature rises through the phonon region, then rapidly with the onset of excitation of rotons. Above 0·05°K, the velocity associated with the leading edge of the received pulse appears to be independent of pulse energy and the degree of distortion. A.

536.52 : 523.77

3391. Measurement of terrestrial temperatures by comparison with the sun. R. H. WILSON, JR. *Observatory*, **73**, 235–6 (*Dec.*, 1953).

Kirchhoff's law of line-reversal is used to measure the temperature of a gas intercepting radiation from a hotter luminous source. For laboratory sources, e.g. carbon arc, the method is restricted to the

measurement of gas temperatures <3800°K. Using the sun as incandescent source, temperatures have been obtained for H–F (4300°K), and CN–O (4640°K) laboratory flames. D. R. BARBER

536.52 : 535.23.08

A photometric method of determining configuration factors. *See Abstr.* 3249

536.53

3392. Use of thermistors in precise measurement of small temperature differences. Thermometric determination of molecular weights. R. H. MÜLLER AND H. J. STOLTEN. *Analyt. Chem.*, **25**, 1103–6 (*July*, 1953).

No extensive data are available on the reliability and strict reproducibility of thermistors. Because every thermistor possesses several variable physical properties, specific information is needed concerning the selection of any one of these for use. The selection of a high resistance thermistor and circuitry applying to the precise measurement of small temperature differences are described. Tables of data concerning thermistor characteristics, their reliability and reproducibility, have been obtained. The resulting apparatus is used for the thermometric determination of the molecular weight in solution of several non-volatile solutes in various solvents. The magnitude of the signal produced by thermistors permits analytical determinations with a precision exceeding 1%. A.

536.58

3393. An electronic model of an "on-off" thermal regulator within its zone of operation. A. S. ALEKSEEV. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 3, 393–6 (1952) *In Russian.*

Over a certain small zone of temperatures, the regulator is on or off according as the temperature is rising or falling. The model is designed to simulate the performance of an oven when controlled by this type of regulator. J. M. HOUGH

536.631

3394. On θ values in metals. II. F. M. KELLY. *Canad. J. Phys.*, **32**, 81–9 (*Jan.*, 1954).

The four methods of Pt I [Abstr. 1594 (1953)] for calculating θ_D, the Debye characteristic temperature for specific heats, and θ_R, the characteristic temperature which appears in the quantum theory of electrical resistance, are applied to copper, silver and gold. An allowance has also now been made for the variation of electrical resistance with volume to take into account the effects of thermal expansion before θ_R is calculated and compared with θ_D. Revised values of θ_R for lithium and sodium are given. A.

536.631

3395. A new semi-automatic apparatus for measurement of specific heats and the specific heat of sodium between 55 and 315°K. T. M. DAUPHINEE, D. K. C. MACDONALD AND H. PRESTON-THOMAS. *Proc. Roy. Soc. A*, **221**, 267–76 (*Jan.* 21, 1954).

An apparatus has been developed for the semi-automatic measurement of specific heats from room temperature to the liquid-hydrogen range. A dynamic system, involving continuous heat input to the sample, is made possible by the use of a relatively small sample together with a large effective surface area for the heaters. Adiabatic conditions can then be maintained automatically. All data relevant to the specific heat determination (time, power input and temperature) are recorded on a single chart. The operator is required only for periodic switching (which could in principle also be automatic). The specific heat of sodium has been studied between 55 and 315°K with this apparatus. The predicted limits of accuracy (±0·1%) appear to be approached rather closely. A small anomaly, showing some hysteresis effects, appears in the region of 200°K. A.

536.631 : 536.48

3396. Measurements of the specific heat of metals at very low temperatures (cadmium from 0·3 to 0·9°K). B. N. SAMOĬLOV. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 2, 281–4 (1952) *In Russian.*

Author gives a detailed description of his calorimeter for use at magnetic cooling temperatures. The temperature is measured with a bronze thermometer which is calibrated corresponding to the susceptibility of a paramagnetic salt, corrections being made for adjusting to the thermodynamic scale. The salt $[Fe(NH_4)(SO_4)_2]$ was used for producing cold. Experimental errors due to insufficient vacuum are avoided by means of an "adsorption pump." Measurements of the specific heat of cadmium were made. Results for the superconducting range are in accordance with observations of the critical field strength. The specific heat is found to be proportional to T^3. Measurements beyond the transition point can be represented by the formula: $C = [1{\cdot}70\ 10^{-4}T + 464(T/300)^3]$ cal/mole deg. The linear term does not fully agree with the value derived from magnetic measurements. A relatively large number of measurements were made in the transition range, between 5 and 5·5°K. R. EISENSCHITZ

536.632 : 536.222

3397. Specific heat, specific volume and thermal conductivity of high polymers. II. Dependence on chain length for fractionated polystyrenes. K. UEBERREITER AND E. OTTO-LAUPENMÜHLEN. *Z. Naturforsch.*, **8a**, 664–73 (*Oct.*, 1953) *In German.*

For Pt I, see K. Ueberreiter and S. Nens, *Kolloid Z.*, **123**, 92 (1951). Reports measurements of the specific heat C_p of three polystyrenes (molecular weights 860, 2300 and 3650) between 260° and 450°K, covering the freezing point. The thermal conductivity was measured over the same range. E. P. WOHLFARTH

536.632 : 536.444

3398. Heat capacity of water-phenol solutions in the critical region. KH. I. AMIRKHANOV AND I. G. GURVICH. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 2, 221–3 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF–tr–97.*

C_p for a critical mixture is found to remain constant at 8·3 ± 0·3 cals/g deg as the temperature is raised through T_c. Earlier reports of a sharp increase [Khomyakov, Kholler and Nekrashevich, *Zh. fiz. Khim.*, **25**, 1469 (1951)] are shown directly to be due to failure to destroy the large temperature gradients which are built up near T_c. R. O. DAVIES

THERMODYNAMICS 536.7/.8

536.7

3399. On the thermodynamics of irreversible processes. II. K. Popoff. *Z. angew. Math. Phys.*, **3**, *No.* 6, 440–8 (1952) *In French.*

Previous work [Abstr. 3558 (1952)] is extended, the change of entropy being considered in its most general formulation. It is shown that the symmetrical relations $L_{ik} = L_{ki}$ are a result of the first approximation only. F. E. HOARE

536.7

3400. The theory of irreversible processes. IV. H. G. Reik. *Ann. Phys.* [*Leipzig*] **13**, *No.* 1–5, 73–96 (1953) *In German.*

For Pt III, see Abstr. 5151 (1953). The time axiom of Pt I [Abstr. 5149 (1953)] is applied to systems where several processes occur concurrently. The interaction of these is expressed in the "integrability theorem": the velocities of the n processes can be expressed as the partial differential quotients of a single function, connected with the entropy increase caused by these processes. The theory is applied to the effusion of Knudsen gases and gives the right values. If the time axiom is expanded for the Onsager forces at the equilibrium state, and the series is broken off after the linear term, it gives the Onsager equations. In expansion for non-equilibrium states, relations are found between the linear coefficients, and also between the quadratic coefficients, if the series is broken off after the quadratic terms. C. TURNER

536.7

3401. On the thermodynamics of irreversible processes. III. R. Haase. *Z. Naturforsch.*, **8a**, 729–40 (*Nov.*, 1953) *In German.*

For Pt II, see Abstr. 1747 (1952). The problems arising in the formulation of the first law for open systems are discussed. It is shown that the idea of a heat stream may be introduced by definition. The advantages of using the so-called reduced heat stream are explained. The thermal conductivity of binary chemically reacting systems is discussed with particular reference to a simple derivation and to the Nernst formula for the thermal conductivity of a dissociating ideal gas. The range of applicability of the principle of minimum entropy production for stationary states is examined. F. E. HOARE

536.7

3402. On the heat of reaction. J. E. Verschaffelt. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 3, 285–92 (1953) *In French.*

The thermal effect of molecular transformations is calculated first for a homogeneous mixture forming a closed system and then in an inhomogeneous fluid mixture where they effect the transport of matter and energy. F. E. HOARE

536.7

3403. Energy dissipated by molecular transformation. J. E. Verschaffelt. *Bull. Acad. Roy. Belgique Cl. Sci.* **39**, *No.* 5, 463–73 (1953) *In French.*

See preceding abstract. The author develops the theory of fundamental reactions the rate of which varies as their affinity. For a single chemical reaction the dissipated energy is proportional to the square of affinity, and a similar relationship is derived for a number of reactions, provided each constituent takes part in one reaction only. The general case, that of constituents taking part in more than one reaction, is analysed. When applied to the process of evaporation-condensation, the reasoning leads to known thermodynamical relationships. F. LACHMAN

536.7

3404. On the minima of energy dissipation. J. E. Verschaffelt. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 4, 369–80 (1953) *In French.*

The possibility of the realization of a minimum in the dissipation of energy by diffusion combined with molecular transformations is examined. Additional reflections to those made in a previous paper of the same title [Abstr. 4068 (1953)] are given. F. E. HOARE

536.7

3405. On the calculation of dissipated energy. J. E. Verschaffelt. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 10, 798–815 (1953) *In French.*

See preceding abstract.

536.7

3406. On the equilibrium of a mixed fluid. J. E. Verschaffelt. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 2, 169–74 (1953) *In French.*

The distribution of matter in a mixed fluid in mechanical equilibrium is examined. The case where molecular transformations take place is also examined and it is concluded that mechanical and chemical equilibrium can only be achieved simultaneously when the physical state is the same throughout. F. E. HOARE

536.7

3407. On the general equilibrium of a mixed fluid. J. E. Verschaffelt. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 7, 612–21 (1953) *In French.*

The author's method of dealing with this problem is compared with alternative treatments. The condition of equilibrium appears definite, but the velocity remains indeterminate. F. E. HOARE

536.7

3408. The application of Jacobians to statistical thermodynamics. H. Einbinder. *J. chem. Phys.*, **21**, 2134–42 (*Dec.*, 1953).

Shaw's Jacobian method for calculating thermodynamic derivatives is extended so that any partial second derivative can be expressed in terms of two sets of reference derivatives based on the independent variables (V, T) and (P, T) respectively. A simplified and enlarged table of second-order Jacobians is given in terms of these reference sets. Methods are developed for obtaining the reference J's explicitly in the cases of greatest importance in statistical thermodynamics, i.e. from A, E, the partition function and the caloric equation $PV = sE$, permitting any first or second partial derivative to be found as an explicit function of (V, T). These J's are given for the polyatomic ideal and van der Waals gases, black-body radiation, the general (relativistic and nonrelativistic) quantum gas, and the general degenerate Bose–

Einstein and Fermi–Dirac gases. Their great usefulness is illustrated, and the possible application of reference Jacobians in evaluating semi-empirical theories of liquids and gases is noted. Finally, the classical theory of thermodynamic fluctuations is extended using Jacobians. General formulae are derived which give explicitly the total variance, partial variance and covariance of the fluctuation of any thermodynamic variable from its equilibrium value. A.

536.7 : 530.145

Quantum mechanics and thermodynamics continuity. *See Abstr.* 3134

536.7 : 530.162

3409. Electric polarization in thermomechanics. J. E. VERSCHAFFELT. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 10, 816–37 (1953) *In French.*

The author introduces the electric polarization into the equations of thermomechanics, and compares his procedure with that used by other authors. The drawbacks inherent in the latter are pointed out. F. LACHMAN

536.7 : 530.162 : 536.42

3410. Statistical fluctuations and thermodynamic stability. A. MÜNSTER. *Z. Phys.*, **136**, *No.* 2, 179–205 (1953) *In German.*

The author seeks to generalize his statistical theory of phase changes, based on the Gibbs grand canonical ensemble [Abstr. 2427 (1953)]. He shows that the partition functions of statistical thermodynamics can be transformed into each other by means of Laplace transforms. For infinitely large systems and under certain conditions these become the Legendre transforms of the thermodynamic potentials. The relative mean square fluctuations of the extensive parameters vanish for infinitely large systems under the same conditions. These conditions are shown to be identical with the conditions of thermodynamic stability. Where these conditions are not satisfied, a phase change results. Various possible statistical descriptions of phase transitions are discussed, and the conclusion is drawn that it is impossible to define statistically thermodynamic functions of completely unstable phases, while those of metastable phases are definable only under certain assumptions. T. P. BRODY

536.7 : 577.3

Thermodynamical analysis of life. *See Abstr.* 4052–4

536.74

3411. Determination of thermodynamic temperatures [illegible] 0°K without introducing heat below 1°K. W. F. GIAUQUE. *Phys. Rev.*, **92**, 1339–45 (*Dec.* 15, 1953).

Various methods of introducing heat in the region of temperature and magnetic field accessible below 1°K are compared and their experimental limitations are pointed out. The fact that all thermodynamic properties can be determined in the above region without introducing heat below 1°K is discussed. This fact also applies to the use of Kelvin's equation $dQ = TdS$, in the determination of thermodynamic temperature. A.

536.77 : 548.7

3412. Tables of thermodynamic functions for chain and layer structures. N. A. CHERNOPLEKOV. *Zh. fiz. Khim.*, **27**, *No.* 7, 1090–102 (1953) *In Russian.*

See previous tables [*idem, ibid.*, **25**, 878 (1951)]. Following V. V. Tarasov's methods the oscillational internal energy and free energy of chain and layer structures (heterodynamic systems) have been calculated and are tabulated in terms of Debye characteristic temperatures. Examples of the use of the tables for calculating the free energy and internal energy of $MgSiO_3$, $MgCl_2$ and solid HF at various temperatures are given. A. L. MACKAY

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537.2

3413. Static electrification. *Brit. J. appl. Phys. Suppl. No.* 2, 104 *pp.* (1953).

This contains the papers read at a conference held in London in March, 1953. They are arranged under four headings: General principles; Useful applications; Electrostatic machines; Harmful static electrification. For abstracts, see Abstr. 3415–36, 3420–1 (1954).

537.21

3414. An electrometric method of measuring the Volta effect. G. NADZHAKOV. *Izv. Bulg. Akad. Nauk.*, **2**, 341–56 (1951) *In Bulgarian.*

The measuring system represents an asymmetrical torsional balance, the asymmetry referring to the height of the pairs of quadrants. Both pairs of quadrants are at zero (earth) potential. The potential applied to the needle causes the latter to deflect to such an extent that the luminous spot will leave the scale of the instrument in the direction of the higher quadrants. This electrostatic torsion is compensated by a mechanical torsion of the system suspension until the spot returns and settles at a certain scale point. The sign of the potential is then inverted by commutation. The spot should remain in its place, but it usually assumes another position. This is due to the contact potential difference between needle and quadrant block, the sign of which is not changed by commutation and therefore first increases, and then diminishes the absolute value of the auxiliary potential. An accumulator with a potentiometer circuit permits of compensating, and thus of measuring, the Volta effect. The advantages over the classical method are a greater sensitivity because the p.d. and not induced charges are measured; the system suggested needs itself no insulation, because the only required insulation is that of the suspension system which need not be elaborate (any commercial insulator, glass or even wood will do). Using the deflection method, any change of the Volta effect may be observed continuously. The system is very easy to build and may be used *in vacuo* without difficulty. B. F. KRAUS

537.212 : 621.317.72

3415. Two electrostatic field-meters. A. S. Cross. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 47–S 50 (1953).

Two electrostatic field-meters are described, one operating from a.c. mains and the other from dry batteries. An alternating potential proportional to the field is generated by the measuring head, amplified, and fed to a phase-sensitive rectifier. The mains-operated instrument gives, at full sensitivity, an output current of 1 mA for a field of about 400 V/ft, the direction of the current depending upon the sign of the field. Its sensitivity can be adjusted over a range of 900 : 1; at maximum sensitivity the zero drifts by no more than 2% of the full-scale reading in 15 hr. The battery-operated instrument, which is truly portable, has two fixed ranges giving full output current for fields of 5 and 50 kV/ft; its sensitivity is hardly affected by normal changes in battery voltages. A.

537.217 : 67

3416. Electrostatic coating processes. R. Tilney. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 51–S 55 (1953).

Describes the three methods of applying static electricity in the production of parts to which it is required to apply liquid coating. Development of these processes has led to their commercial application, in the first case by the introduction of particles of coating material atomized by compressed air into an electrostatic field; in the second case by the removal of surplus coating material from parts coated by dipping; in the third case by direct application of the coating material atomized and deposited by electrostatic force. The principles of these three processes are described and also mechanical and electrical arrangements for their application to commercial production. Finally some details are given of the types of production at present being handled and a summary of the results achieved by way of coating material savings. A.

537.221

3417. Survey of generation and dissipation of static electricity. P. S. H. Henry. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 6–S 10 (1953).

A general account is given of the principles used in measuring contact electrification, and of the difficulties due to discharges in air and to unknown contact areas. The nature is discussed of the information which might be obtained from work on this subject, and a list is made of the various mechanisms which have been proposed in the past, together with one new hypothesis. The suggestion is made that these are by no means mutually exclusive, and a simple form of theory is worked out to illustrate how several of them might be expected to operate together. A.

537.221

3418. The dissipation of electrical charges generated by rollers. J. A. Medley. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 23–S 27 (1953).

It is shown that over a large range of roller pressures, gaseous discharge imposes an upper limit to the charge density of clean, poorly conducting wool cloth or rovings; this can be further reduced by conductors auxiliary to the rollers and designed to concentrate locally the lines of force. Dissipation by conduction back through the material to the point of contact is distinguished from discharge through surface contaminant, which behaves as a leaky dielectric in the region of contact. It is confirmed experimentally that electrification rapidly disappears as the bulk conductivity of a surface agent attains a calculable critical value in practice of the order of $10^{-9}\ \Omega^{-1}\ cm^{-1}$ or, where the material itself conducts, as a parameter K approaches unity; K may be defined for fibre assemblies as well as for homogeneous materials in terms of speed, external dimensions and a directly measurable resistance. A.

537.221 : 532.51

3419. The electrification of fluids in motion. W. F. Cooper. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 11–S 15 (1953).

The electrification of electrolytes by flow in pipes can be explained in terms of the Helmholtz electrical double layer, and it is suggested that some sort of double layer is also produced in commercial grades of organic liquids, such as petroleum, by impurities. The charge produced is expressed in terms of the electrokinetic potential and the Reynolds number. With an immersed discharge electrification will not be observed unless the resistivity exceeds about $10^{11}\ \Omega$ cm. It is pointed out that the theory is closely associated with hydrodynamics and that in experiments the requirements of dynamic similarity must be observed if important scale effects are to be avoided, and the theory is extended to charges formed on filters and in washing fabrics. Such published experimental work as is available is consistent with the theory set out. The electrification of drops, spray and wet steam is also discussed briefly. A.

537.221 : 532.51

3420. Liquids giving no electrification by bubbling. W. R. Harper. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 19–S 22 (1953).

The contention of Gill and Alfrey that electrification by splashing is due to electrostatic induction in the field of a contact potential is discussed in the light of other published work, and it is concluded that this contention cannot be upheld. The orthodox view that electrification of this kind arises from the existence of a double layer in the vicinity of the liquid surface suggests that there should be no charging with a non-conducting liquid, contrary to what has been found by previous workers. Experiments using the method of bubbling are described which show that the electrification does disappear, even with much more sensitive apparatus than previously used, if the purification of a liquid has been carried far enough to reduce its conductivity to below 10^{-13} mho cm^{-1}. The liquids used were hexane, octane, decane, benzene, xylene, pinene, carbon tetrachloride and a mixture of xylene and carbon tetrachloride. The non-conducting liquids still produce considerable quantities of neutral centres. A.

537.221 : 532.61

3421. The electrostatic charging of some polymers by mercury. J. A. MEDLEY. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 28–S 30 (1953).

A method is described by which very heavy charge densities may be measured after separation. The influence of externally applied fields on the apparent electrification is described, and also the electrostatic contribution to hysteresis of contact angle. A.

537.221 : 536.421.4

3422. Electrification by freezing. E. W. B. GILL. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 16–S 18 (1953).

The high potentials of the order of 100 V developed when ice is formed from dilute solutions were investigated to discover the mechanism. Contact potentials between solids and liquids are usually of the order of 1 V and some further fact must operate to achieve 100 V. The theory suggested is that, whereas in the usual case the charges producing the potentials are adjacent to the boundary, in the case of freezing ice the charges extend to a small distance from this boundary. A.

537.221 : 537.311 : 621.319

3423. Methods of increasing the electrical conductivity of surfaces. J. S. FORREST. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 37–S 39 (1953).

Difficulties due to electrostatic charges on insulating surfaces can be overcome by coating the surface with an electrically-conducting film. The paper describes conducting films of metallic oxides, metals, carbon, moisture and wetting agents. Information is also given on the application of these films to ceramic and plastic insulating materials. A.

537.221 : 537.534

3424. Ten years of research on electrostatics at the University of Grenoble 1942–1952. N. J. FELICI. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 62–S 67 (1953).

The emphasis is on the practical development and application of electrostatic generators, rather than on theoretical considerations. The small cylindrical compressed-gas generators with conducting segments proved very satisfactory for powers of the order of 30 W at voltages of 70 kV. In attempts to increase the output multiplate generators with conducting segments were evolved which reached 750 W at 250 kV, but beyond this range difficulties of mechanical construction proved formidable. After disproving the current view that charge slip was responsible for the low output of moving insulator machines, a cylindrical generator of this type was constructed with highly encouraging results. A.

537.221 : 539.11

3425. Theory of contact electrification. F. A. VICK. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 1–S 5 (1953).

After an outline of the relevant parts of the modern theory of solids, the transfer of electrons when metals, semiconductors and insulators are placed in contact is discussed. The importance of surface states is stressed. A.

537.221 : 539.62

3426. The role of asymmetric rubbing in the generation of static electricity. P. S. H. HENRY. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 31–S 36 (1953).

Two independent types of contact electrification are discussed; the one requiring different surfaces, but not needing friction; the other requiring asymmetric rubbing, but not a difference in the surfaces. It is suggested that the combination of these two effects which occurs when different surfaces are rubbed together (usually asymmetrically) is a contributory factor to the notorious uncertainty of such experiments. It is shown that almost all rubbing processes involve local asymmetry, with the result that like surfaces rubbed together, though each neutral as a whole, are covered with a pattern of opposite charges. A similar effect accounts for the different triboelectric behaviour of surfaces of the same material but different degrees of roughness, and occurs as a complication in the rubbing together of different materials. The part played by asymmetric rubbing between two solids in observed transference of charges to the air is discussed. Experiments are described in which all possible pairs of ten different materials are brought into contact by a method involving the minimum of rubbing. It is shown that the results, with very minor exceptions, are in accordance with the existence of a self-consistent electrostatic series. The separation of charge by the asymmetric rubbing of like surfaces is discussed, and the hypothesis suggested that it is due to the thermal gradient across the interface, and that it is analogous to thermal diffusion and to the Thompson thermoelectric effect in metals. As yet little experimental evidence exists to test this hypothesis, but suggestions are made as to how it might be obtained. A.

537.221 : 541.126

3427. The electrostatic ignitibility and electrification of finely powdered Hexamine. A. G. PEACE. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 94–S 96 (1953).

It is shown that finely divided dry Hexamine powder when dispersed in a dust cloud can be ignited by electric sparks of energy less than 0·005 J and that certain previously established principles of spark ignition apply also to this substance. No ignition of heaped powder by similar means could be produced. The powder is shown to be readily electrified in various mechanical operations similar to those used in manufacturing processes, charges of the order of 10^{-9} C/g being produced. A.

537.221 : 541.126 : 614.83

3428. The ignition of explosives by condenser discharges—effect of added circuit resistance. G. MORRIS. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 97–S 100 (1953).

To investigate the mechanism of ignition of explosives by capacitance sparks, the critical ignition energy of lead trinitroresorcinate was examined for a wide range of capacitance and series resistance. The experimental data do not completely conform to the same energy/time relation as for ignition by hot wires. A useful empirical relation is, however, found.

The use of added resistance in earth lines is shown to decrease plant safety. A.

537.221 : 545

3429. The measurement of oxidation of coal by static electrification. D. G. A. THOMAS. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 55 (1953).

The electrostatic charge acquired by a stream of fine coal particles after making contact with a metal surface has been found to be related to the degree of oxidation of the coal. The effect forms the basis of an instrument for quality control in an oxidation plant.

537.221 : 616–7

3430. Factors in the design of an operating theatre free from electrostatic risks. D. BULGIN. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 87–S 91 (1953).

A theoretical treatment is given of the factors governing the voltage attained by surfaces under stated conditions of separation and electrical resistance. The results are supported by observed values and indicate that the resistance of rubber articles (measured under conditions defined by British Standard Specifications for anti-static and conductive rubbers) should lie between 100 000 Ω and 10 MΩ. It is considered that only "anti-static" (conductive) rubber and cotton surfaces should be permitted in operating theatres and that the relative humidity of the atmosphere should exceed 65%. A.

537.221 : 616–7

3431. Safety measures in operating theatres and the use of a radioactive thallium source to dissipate static electricity. A. QUINTON. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 92–S 94 (1953).

Precautionary measures to minimize the risk of explosions due to the ignition of anaesthetic gas mixtures are described briefly. Special attention is given to the elimination of charges of static electricity, including the use of an apparatus incorporating a radiothallium source. The apparatus causes a stream of air to pass over the radiothallium and the ionized air so produced is effective in removing electrostatic charges at distances up to 6 ft. The radiation risk to theatre personnel is negligible. Some interesting measurements concerned with the safety of the use of plastics and the wearing of nylon stockings are given. A.

537.221 : 629.11 : 621.319.7

3432. Static electricity on rubber-tyred vehicles. D. BULGIN. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 83–S 86 (1953).

The electrostatic charge which originates at the separation of the tyre tread from the road raises the potential of road vehicles to a maximum of 100 kV, the value depending on roughness of the road surface, vehicle speed and tyre tread resistance. The interconnection of these factors is given in the paper with both experimental and theoretically derived values of voltage. Harmful effects include shock from the vehicle, radio interference (small) and puncture of the inner tube due to ozone originating between the tube and the inner wall of the tyre. Elimination of these effects is obtained using tyres of electrical resistance of $<10^9$ Ω. A.

537.221 : 66/69

3433. Survey of harmful static electrification. H. W. SWANN. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 68–S 70 (1953).

A survey of the history of harmful static electrification in industry is given together with examples and various remedies considered. A.

537.221 : 66/69 : 614.825 : 621.319

3434. The practical estimation of electrostatic hazards. W. F. COOPER. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 71–S 77 (1953).

Deals with experimental procedure and methods of calculation. An attempt is made to provide a basis for the quantitative study of electrostatic hazards met in industry and attention is drawn to several important details frequently overlooked. It is shown that a material cannot retain a bulk charge unless its resistivity exceeds about 10^{11} Ω cm and that vessels will not remain significantly charged unless they are very highly insulated. This depends very largely on the relative humidity of the air, and for this reason experimental work and measurements may present considerable difficulties in Britain. Problems of static electrification can be stated conveniently by a generalization of Maxwell's coefficients; examples are given, including a discussion of the interpretation of the indications of certain instruments, and the surface potential of a charged liquid in an earthed container—such as a bowl or a storage tank. The notation is suitable for other electrostatic problems as well as those considered. A.

537.221 : 66.074 : 621.357.9 : 621.319

3435. The physics of electrostatic precipitation. H. J. LOWE AND D. H. LUCAS. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 40–S 46 (1953).

Summarizes the existing theories of the behaviour of particles in an electric field with special reference to the electrostatic precipitation of flue dust in power stations burning pulverized coal. The theoretical relation between particle size and precipitation efficiency is not borne out in practice and an endeavour is made to resolve the discrepancy by considering the molecular and electric forces acting on particles after they have been deposited on the collecting electrodes. A.

537.221 : 677 : 621.319.7

3436. Electrostatic eliminators in the textile industry. P. S. H. HENRY. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static electrification*] S 78–S 82 (1953).

The occurrence of static electricity in the textile industry, and the ways in which it interferes with production, are briefly described. The general principles of its dissipation are discussed, with special emphasis on the time factor. Brief descriptions are given of the various types of electrostatic eliminator, both electric and radioactive, used in the textile industry, with references to the commercial apparatus. A.

537.222

3437. On the kinetics of the formation and the relaxation of space charge. É. I. ADIROVICH. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 6, 1085–7 (1952) *In Russian.*

A mathematical treatment based on Maxwell's equations and the diffusion equation of the behaviour of space charge. The case of applied electric fields is also considered. J. M. HOUGH

537.222 : 621.315.615

3438. Homocharges in insulating oils under the action of a constant potential difference. R. GUIZONNIER. *J. Phys. Radium*, **14**, 55 S–56 S (*Dec.*, 1953) *In French.*

Describes the results of experiments with paraffin and other oils as the dielectric of a cylindrical condenser in which there is a field of 1500 V/cm. The existence of a space-charge and its variation with time is demonstrated. There is agreement with Gross's theory on the formation of homocharges in electrets. A. E. KAY

537.226

3439. The dielectric relaxation of polar molecules in solution. N. E. HILL. *Proc. Phys. Soc.* [*London*] *B*, **67**, 149–58 (*Feb.*, 1954).

A simple theory of dielectric relaxation is proposed, based on the same model of a liquid as Andrade's theory of viscosity. It is shown that the relaxation time of a polar molecule in solution in a non-polar solvent should be related, not to the viscosity of the solvent, but to the "mutual viscosity" of the solute and solvent. This quantity can be calculated from the variation of the viscosity of the solution with concentration, since the viscosity η_m of a mixture containing mole fractions f_A and f_B of the two substances A and B is shown to be

$$\eta_m = f_A^2\eta_A\frac{\sigma_A}{\sigma_m} + f_B^2\eta_B\frac{\sigma_B}{\sigma_m} + 2f_Af_B\eta_{AB}\frac{\sigma_{AB}}{\sigma_m}$$

where the σ's are intermolecular distances, and η_{AB}, the mutual viscosity, represents the contribution to the total viscosity of collisions between a molecule of substance A and a molecule of substance B. The theory shows satisfactory agreement with experimental results both for pure liquids and for solutions. A.

537.226 : 621.319.3 : 621.315.618

3440. Dielectric properties of pure hydrogen and its use in electrostatic generators with insulating [charge] carriers. N.-J. FÉLICI. *C.R. Acad. Sci.* [*Paris*] **237**, 979–82 (*Oct.* 28, 1953) *In French.*

Lists certain disadvantages of halogen-containing gases (SF_6, etc.) for high-pressure gaseous insulation and shows that hydrogen is in many respects preferable. Mechanical and electrical quantities are involved. J. D. CRAGGS

537.226–972

3441. Dielectric properties of some polymorphous compounds. F. M. GOL'TSMAN AND SH. SH. RASKIN. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 5, 817–19 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-118.

Measurements of ε' and ε'' for the solid and for weak and strong solutions at 3·2 cm are reported for α-Cl camphor, cyclohexanol, borneol and bornyl chloride which have relaxation times of the same order of magnitude in the two states. α-Br camphor, in contrast, has no loss in the solid and no second-order transition. D. H. WHIFFEN

537.226.1 : 548·7

3442. Clausius–Mosotti equation for certain types of anisotropic crystals. H. E. J. NEUGEBAUER. *Canad. J. Phys.*, **32**, 1–8 (*Jan.*, 1954).

The Clausius–Mosotti equation is derived for crystals whose particles are anisotropic and arranged in any lattice provided that all the particles are of the same type and provided that the principal axes of their tensors of polarizability are parallel to each other. The formulae are of special interest for artificial dielectrics used as lens material for microwave frequencies. They explain experimental results. A.

537.226.2

3443. Peculiarities of behaviour of ferro-electric ceramics near the Curie point. N. P. BOGORODITSKIĬ AND T. N. VERBITSKAYA. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 3, 447–9 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-44.

Ageing of these materials is shown by decrease of dielectric permittivity ε and dielectric loss with time [Abstr. 6758 (1953)]. Insulation resistance does not change with time. Tests at 20°C show materials with Curie point 35°C have ε initially rising to a maximum value in a weak uniform field, then dropping rapidly. Material with Curie point 125°C has ε decreasing without going through a maximum value; materials with Curie point 135°C do not show any change of ε with magnitude of uniform displacing field. J. LUKASZEWICZ

537.226.2

3444. Microwave measurements of the dielectric constant of some powdered solids. J. BARUCH AND W. LOW. Letter in *Bull. Res. Coun. Israel*, **2**, 430–1 (*March*, 1953).

From measurements at 3·1 cm, the formula obtained by Böttcher [*Recueil Trav. chim. Pays-Bas*, **64**, 47 (1945)], for obtaining the dielectric constant of a solid from measurements on a powder, is verified for NaCl. $CuSO_4.5H_2O$ shows marked increases of ε' and $\tan\delta$ at 92–99°C and near 150°C at which temperatures the water is freed before being driven off. $CaCl_2$ to which H_2O is added shows a rapid fall in ε' and $\tan\delta$ as the H_2O becomes bound. D. H. WHIFFEN

537.226.2

3445. Method for the measurement of the dielectric constant of gases in the hyperfrequency region. A. GOZZINI AND E. POLACCO. *C.R. Acad. Sci.* [*Paris*] **237**, 1497–9 (*Dec.* 9, 1953) *In French.*

The gas fills a cavity resonator whose change of resonant frequency at 9500 Mc/s is observed by comparison with a second empty cavity. The frequency difference between the cavities is obtained by observing the difference in time between their responses as the oscillator is swept over a known amplitude. D. H. WHIFFEN

537.226.2

3446. Direct measurement of the dielectric constants of silicon and germanium. W. C. DUNLAP, JR AND R. L. WATTERS. *Phys. Rev.*, **92**, 1396–7 (*Dec.* 15, 1953).

Measurements between 500 c/s and 30 Mc/s were made. Small parallel-plate condensers were made from samples of these elements after doping with gold so as to produce high-resistivity material ($\rho \sim 10^7$ ohm cm for germanium at 77°K $>10^{10}$ ohm cm for silicon). The dielectric constant of silicon (at 1 Mc/s) was taken to be $11{\cdot}7 \pm 0{\cdot}2$, of germanium $15{\cdot}8 \pm 0{\cdot}2$. The dielectric constant of silicon is constant to $\pm 1\%$ over the range 500 c/s–30 Mc/s, whereas germanium, because of its lower resistivity, has a much greater apparent variation of dielectric constant with frequency. A.

537.226.2

3447. Investigations in physics. No. 1: ferroelectricity. E. T. JAYNES. *Princeton: University Press; London: Oxford University Press*, 142 *pp.*

Review in *Phil. Mag.*, **45**, 235 (*Feb.*, 1954). "This book is an expansion of a doctoral thesis and is concerned mainly with the theory of ferroelectricity. It opens with a brief account of the properties of Rochelle salt and KH_2PO_4 and the theories put forward to account for their behaviour. The author then discusses at greater length the properties of $BaTiO_3$ and the theories relating it, in particular to his own electronic theory. There is then a brief account of the general thermodynamic properties of ferroelectrics, and the remaining one-third of the book is devoted to methods of evaluating internal fields in crystals and finding the conditions for spontaneous polarization."

537.226.2 : 535.376

3448. Explanation of the increase of the dielectric constant of crystallophosphors by irradiation. M. BORISOV. *Izv. Bulg. Akad. Nauk*, **2**, 281–92 (1951) *In Bulgarian.*

The author showed in a previous paper that a considerable increase of the diel. const. of irradiated crystallophosphors ZnS.CdS–Cu is accompanied by a comparable increase of the dielectric losses. The present paper presents formulae for capacitance and loss resistance (expressed as a parallel resistance) of a capacitor consisting of n parallel layers, of different diel. const. and conductivity, when an alternating voltage is applied. These formulae applied to measurements on a capacitor with two dielectric layers, one of which was a glass plate and the other a thin layer of the crystallophosphor provide a proof that the increase of the capacitance under irradiation is a phenomenon which may be satisfactorily explained by the increase of the dielectric losses in the crystal layer. B. F. KRAUS

537.226.2 : 539.21

3449. Structure and dielectric properties of carbon-black rubber compounds. B. DOGADKIN AND A. LUKOMSKAYA. *Dokl. Akad. Nauk SSSR*, **88**, *No.* 6, 1015–18 (1953) *In Russian.*

Variations of dielectric permittivity and loss angle with frequency and temperature were investigated in non-vulcanized rubbers, rubber/carbon-black compounds and vulcanizates with different percentages of gas black and thermal black. Presence of carbon-black in rubber results in losses divisible into those of a non-uniform dielectric, conductivity and structural. Losses depend on quantity and type of black and type of rubber. Mechanical properties of vulcanizate depend on formation of carbon-black structures in compounds in which interaction of carbon-black particles is greater than energy of interaction of rubber and filler. J. LUKASZEWICZ

537.226.2 : 621.3.011.5 : 621.315.61

3450. Dielectric investigations on powders. R. MECKE AND H. SCHILL. *Z. Elektrochem.*, **57**, 270–6 (*April*, 1953) *In German.*

After the sedimentation of a powder in a fluid, the resultant permittivity (ε) of the mixture cannot be calculated from ε values of the two constituents, since the structure of the "internal" field is not known. This unknown structure-dependent factor has been determined experimentally for a number of model systems suspended in fluids the ε of which varied from 1 (air) to 34 (nitrobenzene). Relationships have been established between ε and the structure of constituents, and they enable ε to be determined for different powders (e.g. glass, 6·671; quartz, 4·575; asbestos, 6·309; kaolin, 7·893; kieselguhr, 4·387; ultramarine, 8·273); it is also possible now to evaluate the "packing density" of the mixtures and to investigate the surface phenomena. F. LACHMAN (R)

537.226.2 : 621.317.335.3

3451. Dielectric measurements by a modified standing wave method at microwave frequencies. J. BARUCH AND W. LOW. Letter in *Bull. Res. Coun. Israel*, **2**, 429–30 (*March*, 1953).

If a sample is of high loss and of such a length that back-surface reflection may be neglected, permittivity and loss angle may be measured at 3 cm from the standing-wave ratio and the distance of the first minimum from the sample surface. Troubles with multiple roots of $(\tanh \gamma d)/\gamma d$ (where d is thickness of dielectric), are avoided in the calculations, but high precision in the distance measurement is required. D. H. WHIFFEN

537.226.3

3452. Temperature dependence of dielectric loss in the two-component silicate glass systems K_2O–SiO_2 and PbO–SiO_2. V. A. IOFFE. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 3, 405–8 (1952) *In Russian.*

The dielectric losses at 10 Mc/s of glasses of various compositions of K_2O/SiO_2, PbO/SiO_2 and $PbO/SiO_2/TiO_2$ mixtures, were measured from 10 to 400°K and the results shown graphically. There is a maximum between 70 and 120°K in each case followed by a minimum from 130 to 160°K in the K_2O glasses only. D. H. WHIFFEN

537.226.3

3453. Dielectric relaxation investigations on the questions of the influences of solvent and of the internal mobility of dipolar molecules. H. HASE. *Z. Naturforsch.*, **8a**, 695–707 (*Nov.*, 1953) *In German.*

From thermal heating measurements at 8·84 Mc/s

the loss of a set of solutions of rigid dipoles such as halogenated benzenes, pyridine, etc., in non-polar solvents is observed and related to rotational relaxation times. These are discussed in relation to the macroscopic viscosity, which is shown to be unsatisfactory, as well as the shape and microviscosity. *n*-Dodecyl chloride and a large range of substituted diphenyls were also investigated and discussed in relation to the ellipsoid shape factor and internal rotation. D. H. WHIFFEN

537.226.3 : 548.7

3454. Theory of dielectric relaxation for a single-axis rotator in a crystalline field. J. D. HOFFMAN AND H. G. PFEIFFER. *J. chem. Phys.*, **22,** 132–41 (*Jan.*, 1954).

The dielectric relaxation times associated with a single-axis polar rotator which may occupy several sites as it turns about its axis are calculated in terms of the probabilities of transition from one site to another. Two special cases are considered in detail: (*a*) that in which all of the sites are equivalent, and (*b*) that in which one site is stable with respect to the others. It is assumed that the only important elementary process is a rotational jump to an adjacent site (single-jump hypothesis). Fluctuations of barrier height are ignored. If the dipole has three or more accessible sites, and one is more stable than the others, a distribution of relaxation times develops naturally. The corresponding dielectric loss peak will be somewhat asymmetric. If the sites are all equivalent, only a single dielectric relaxation time is found, and the corresponding dielectric loss peak will be of the simple Debye type. The theory predicts that the dielectric loss peaks in certain polar crystals will become narrower and more symmetrical as the temperature is raised. A.

537.228.1 : 534.121.1 : 621.372.412

3455. Thickness vibrations of piezoelectric crystal plates. Supplement. R. BECHMANN. *Arch. elekt. Übertragung*, **7,** 354–6 (*July*, 1953) *In German.*

An expression is derived for the piezoelectric modulus in the general case when the electric field is inclined at any angle to the crystal plates. Special attention is applied to the most useful practical application, viz. when the field is parallel to the plate surfaces. See also Abstr. 2439 (1953).

H. J. H. STARKS

537.228.1 : 539.32 : 548.1

3456. Elastic constants and piezoelectric crystals. Y. LE CORRE. *Bull. Soc. Franç. Minéral. Crist.*, **76,** 464–79 (*Oct.–Dec.*, 1953) *In French.*

By applying Born's atomic theory of elasticity to piezoelectric crystals, Laval has shown that the general wave equation requires 45 elastic constants and 27 independent piezoelectric coefficients. The same conclusion was reached by the author using a theory based on the assumption of a homogeneous medium. Certain discrepancies in the wave velocities derived from Laval's theory and those from the classical theory are mentioned. An appendix contains the elastic and piezoelectric coefficients of the 32 classes of crystal symmetry. H. J. H. STARKS

ELECTRIC CONDUCTION . CURRENTS 537.3

537.311

3457. Towards the theory of a conductor near a boundary separating two media. A. A. PISTOL'KORS. *Dokl. Akad. Nauk SSSR*, **86,** *No.* 5, 941–3 (1953) *In Russian.*

The cylindrical conductor of radius a, parallel to, and at a distance h from, the plane boundary separating materials of dielectric constant k_1k_2, is excited by an e.m.f. of angular frequency ω. An expression for the propagation constant of the field is derived for $a/h \ll 1$ and for all values of k_1k_2. The particular cases of $k_1 > k_2$ and $k_1 < k_2$, and of a loss-free dielectric cylinder, are considered. W. BARDSLEY

537.311.1 : 530.145

3458. The quantum-statistical theory of transport phenomena. II. On the theory of metallic conductivity. H. MORI. *Progr. theor. Phys.*, **9,** 473–91 (*May*, 1953).

For Pt I, see Abstr. 128 (1954). The main purpose of the present paper is to derive the Bloch integro-differential equation, upon which the modern electron theories of metallic conductivity are based, analytically from the principles of quantum-statistical mechanics. In the first place, a generalization of the phase-space distribution function of Wigner is obtained by means of the integral transformations which may be, in general, different from the Fourier transformation. And the starting-point of the present theory is the equation of motion for the singlet generalized phase-space distribution function, which is derived from the Schrödinger equation for the quantized wave function. The Irving–Zwanzig equation for the Wigner distribution function is immediately obtained from the above-mentioned equation of motion. The generalized phase-space distribution functions of electrons are defined so as to be suitable for Bloch's band scheme, and the equation of motion for the singlet electronic distribution function is obtained. The macroscopic electric current density is defined from the quantized density field with the help of time-averaging procedure over a microscopic interval. If one uses the customary approximation method together with the postulate of random *a priori* phases, the Bloch integro-differential equation is obtained from the equation of motion for the time-averaged electronic distribution function. A.

537.311.3 : 539.166.9

3459. Electrical conductivity induced by ionizing radiation in some polymeric materials. A. J. WARNER, F. A. MULLER AND H. G. NORDLIN. Letter in *J. appl. Phys.*, **25,** 131 (*Jan.*, 1954).

A specially developed Wheatstone bridge capable of measuring resistances up to 10^{17} ohms is used to measure the conductivities of polyethylene, Teflon, polystyrene, co-polymer, polyparachlorostyrene, polyvinyl chloride and Kel–F during irradiation with γ-rays (from Co^{60}). The conductivities of most of the materials increase by about a factor of ten over many hours and, except for Kel–F and polyvinyl-chloride which remain constant, then decrease. An explanation is suggested. W. GOOD

537.311.3 : 539.215

3460. Electrical resistance measurement of powders. H. v. WARTENBERG. *Z. angew. Phys.*, **5**, *No.* 8, 291–2 (1953) *In German.*

Measurement of the specific resistance of powders by compression is inevitably inaccurate because of the presence of pores and oxide skins. In the method described a trough is provided with two pairs of exactly similar vertical electrodes one above the other and a tap at the bottom. Sufficient powder is poured in to cover the lower pair. A suitable salt solution is then run through the trough and its concentration adjusted until the resistance across each pair of electrodes is the same. The resistivity of the powder is then the same as that of the solution. It is essential to select a salt solution which will attack any oxide skin on the particles in order to ensure intimate contact between liquid and powder. Actual values of resistivity are computed as follows: The resistance capacity c (= distance/cross-section) of the electrode pairs is determined by using a solution of known resistivity without the powder and measuring the resistance. The powder and the appropriate salt solution are then run in and the resistance r noted when balance has been reached. The specific resistance of the powder is then r/c. A recommended electrode construction is described. H. G. M. SPRATT

537.311.31 : 538.632

3461. Electrical resistivity and Hall coefficient of sodium tungsten bronze. W. R. GARDNER AND G. C. DANIELSON. *Phys. Rev.*, **93**, 46–51 (*Jan.* 1, 1954).

The electrical resistivity and Hall coefficient of single crystals of sodium tungsten bronze (Na_xWO_3) have been measured as a function of temperature and as a function of sodium concentration. The resistivity decreased linearly with decreasing temperature from 300°K to 125°K and was very nearly constant below 30°K. The resistivity at 26°C exhibited a minimum value of $(3{\cdot}20 \pm 0{\cdot}14)$ (10^{-5}) ohm-cm at $x \simeq 0{\cdot}75$. The residual resistivity at 0°K also exhibited a minimum at $x \simeq 0{\cdot}75$ and had a value of $(1{\cdot}25 \pm 0{\cdot}10)$ (10^{-5}) ohm-cm. The variation of the Hall coefficient with temperature was less than 2% over the temperature range 78°K to 370°K. The Hall coefficient varied inversely with the sodium concentration from $x = 0{\cdot}584$ to $x = 0{\cdot}897$, and over this entire concentration rangé the Hall coefficient corresponded to one free electron for each sodium atom in the crystal. Hence, the anomalous minimum in the resistivity at $x \simeq 0{\cdot}75$ must be attributed solely to an anomalous maximum in the electron mobility. An adequate explanation of the minimum in resistivity does not seem possible in terms of thermal scattering alone. A.

537.311.31 : 539.219

3462. Electrical resistance of ordered alloys. A. K. BUTŸLENKO, V. M. DANILENKO, YU. V. MIL'MAN, YU. V. NAĬDICH, S. A. RŸBAK AND A. A. SMIRNOV. Letter in *Zh. eksper. teor. Fiz.*, **23**, *No.* 6(12), 731–2 (1952) *In Russian.*

Published measurements of the electrical resistance ρ_0 of ordered alloys give plots of ρ_0 against composition which are in approximate agreement with a theoretical formula derived by Smirnov, but this does not predict sharp deviations of the plots from a smooth contour, which actually occur. It is shown that these can be accounted for by differences in the degree of order between alloys of different composition subjected to the same heat treatment. R. C. MURRAY

537.311.31 : 539.23 : 621.315.5.029.6

3463. The electrical properties of a thin evaporated layer of silver at 3000 Mc/s. F. J. TISCHER. *Z. angew. Phys.*, **5**, *No.* 11, 413–15 (1953) *In German.*

The theory is given for reflection and transmission measurements to be interpreted in terms of the conduction. Experimental measurement in a coaxial line at 3000 Mc/s essentially agrees with d.c. measurements giving the conductivity as a function of film thickness. At 170 Å it is $\frac{1}{9}$th of the conductivity of bulk silver. D. H. WHIFFEN

537.311.31 : 539.23

3464. Resistivity of thin silver films. U. OPPENHEIM AND J. H. JAFFE. Letter in *J. appl. Phys.*, **24**, 1521 (*Dec.*, 1953).

Reports disagreement with other workers on the thickness at which the resistivity of silver films rises to high values. W. M. LOMER

537.311.32

3465. Electronic properties of carbons and of their interstitial bisulfate compounds. E. A. KMETKO. *J. chem. Phys.*, **21**, 2152–8 (*Dec.*, 1953).

The conductivity of graphite increases when it is oxidized into graphite bisulphate, this being the result of the expulsion of resonance electrons by the negative ions and the resulting creation of excess holes in the π-band. This study concerns the electronic properties of the bisulphate compounds formed by the oxidation of carbons in sulphuric acid, the range of heat-treatment of carbons extending from 1400°C (baked carbons) to 3000°C (polycrystalline graphite). The resistivities of all samples thus treated decrease with increase in the degree of oxidation. The rate of decrease in resistance depends upon the heat-treatment, the rate being increasingly greater for samples treated to higher temperatures. The curve of the Hall constant of unoxidized carbons *v.* the heat-treatment temperature H has a sharp positive peak at about $H = 2000$°C. The curve rapidly drops on either side of the peak, the coefficient becoming negative and exhibiting a minimum around $H = 1400$°C. The thermoelectric power of all samples studied becomes more positive with oxidation, with maxima appearing for lamellar compounds. The rate of the initial rise is greater for high heat-treatment temperatures. The temperature coefficient of resistance depends strongly upon the ion concentration, changing from negative to positive for carbons heat-treated above 2000°C. On the other hand, the coefficients remain negative and are remarkably independent of ion concentration for carbons treated to temperatures below 2000°C. The results are in general consistent with the electronic model for carbons proposed by Mrozowski whereby the Fermi level is initially depressed during devolatilization of the hydrocarbon material by the formation of a large number of excess holes (heat-treatments below 1400°C) and later steadily rises with the growth of the crystallites towards the top of the π-band, the growth of the crystal planes resulting also in a steady decrease of the energy gap between the π and conduction bands. The

negative Hall coefficient for baked carbons indicates the π-band to be so depleted that the Fermi level drops at least partially below the inflection curve. At room temperature the conduction is therefore semi-metallic in nature for carbons treated to $H < 2000°C$ in contrast with cases for which $H > 2000°C$ where the number of excess holes is relatively small and the current is carried mainly by the holes and electrons thermally activated into the conduction band. A.

537.311.33

3466. Calcium oxide, an amphoteric semiconductor. K. Hauffe and G. Tränckler. *Z. Phys.*, **136**, *No.* 2, 166–78 (1953) *In German.*

Conductivity measurements on CaO at 600°C as functions of oxygen pressure and of substituted cations of various charge show it to be an amphoteric semiconductor. Above 10^{-2} atm. O it is *p*-type and below this pressure, *n*-type. Substitution of Li_2O causes *p*-type conduction in high vacuum, the conductivity increasing with increasing oxygen pressure. Substitution of Y_2O_3 causes the opposite effects.

C. A. HOGARTH

537.311.33

3467. A simple demonstration model of a *p-n* junction. W. Heywang. Note in *Naturwissenschaften*, **40**, *No.* 20, 527–8 (1953) *In German.*

Photograph and brief description of a mechanical model. C. A. HOGARTH

537.311.33

3468. On the problem of defect semiconduction in crystalline selenium. W. Schottky. *Z. Naturforsch.*, **8a**, 457–9 (*Aug.*, 1953) *In German.*

The large difference (factor 80) between hole concentrations obtained by Diestel [Abstr. 461 (1954)] on high conductivity Se ($\frac{1}{4}\,\Omega^{-1}\,cm^{-1}$), from measurements of Hall effect and thermoelectric power is attributed to a large effective mass ($\sim 20m_0$). This also leads to reasonable free path lengths. A tentative explanation of the large mass in terms of quasi-bound holes is given. F. ANSBACHER

537.311.33

3469. Magnetic barrier layers in germanium. E. Weisshaar and H. Welker. *Z. Naturforsch.*, **8a**, 681–6 (*Nov.*, 1953) *In German.*

Previous theoretical work [Abstr. 7872 (1951)] has shown that in a current-bearing semiconductor of high electron and hole concentration the effect of a transverse magnetic field is to cause a considerable change of the density of electron-hole pairs, as long as volume and surface recombination is unimportant. As a result the current-voltage characteristics cease to be linear and the electrical resistance changes by a large amount. This effect has been observed on a small Ge crystal, and a resistance change as large as 4·7 has been measured. Measurements of the frequency-dependence of the effect and of the photoelectric effect are also reported. E. P. WOHLFARTH

537.311.33

3470. On the frequency dependence of semiconductor noise. K. W. Böer and K. Junge. Note in *Z. Naturforsch.*, **8a**, 753–5 (*Nov.*, 1953) *In German.*

Equations are obtained for the noise power of a semiconducting solid, based on an equivalent circuit of three resistors, one capacitor and two current generators. The results can be fitted to experimental results with the appropriate choice of R and C parameters. C. A. HOGARTH

537.311.3

3471. On the electrical properties of InAs. O. Gi Folberth, R. Grimm and H. Weiss. Note in *Z. Naturforsch.*, **8a**, 826 (*Dec.*, 1953) *In German.*

Temperature dependence of conductivity for *n*- and *p*-type specimens. The band width lies between 0·4 and 0·6 eV. C. A. HOGARTH

537.311.3

3472. Effect of traps on carrier injection in semiconductors. H. Y. Fan. *Phys. Rev.*, **92**, 1424–8 (*Dec.* 15, 1953).

The effect of carrier traps on the behaviour of a semiconductor with respect to injected carriers is analysed. Two problems are considered: photoconductivity, and spread of excess carrier concentration under applied field. It is shown that trapped minority carriers, by causing an increase in majority carrier concentration, give rise to increased photoconductivity which may be non-linear with light intensity and have a very long time constant. These conclusions are in agreement with recent experimental results. The drift of excess carriers is treated neglecting diffusion. Expression is obtained for the time and space distribution of excess minority carriers, and the effect of traps on the apparent drift mobility is discussed. A

537.311.3

3473. Lattice-scattering mobility in germanium. F. J. Morin. *Phys. Rev.*, **93**, 62–3 (*Jan.* 1, 1954).

The temperature dependence of lattice-scattering mobility in germanium is determined from conductivity. It is found to be $T^{-1.66}$ for electrons and $T^{-2.33}$ for holes. The result for holes suggests that the valence band is not at the centre of the Brillouin zone. The ratio Hall mobility/conductivity mobility is also determined. It is found to be constant with temperature at $\sim 1{\cdot}05$ for electrons. The ratio for holes shows significant temperature dependence. This suggests that the valence band is composed of multiple surfaces of minimum energy. A

537.311.3

3474. Gold as a donor in silicon. E. A. Taft and F. H. Horn. *Phys. Rev.*, **93**, 64 (*Jan.* 1, 1954).

Resistivity-temperature data show gold produces a donor level 0·33 eV above the occupied band in silicon. A

537.311.3

3475. Electronic conduction in grey tin. J. T Kendall. *Phil. Mag.*, **45**, 141–57 (*Feb.*, 1954).

The conductivity and Hall constant of grey tin alloys containing antimony and gallium were measured over a temperature range of 77°K to 286°K. From the results the number of charge carriers and their mobility were calculated as functions of temperature. Large variations of conductivity and Hall constant in a magnetic field were noted. A comparison is drawn with the similar semiconductors silicon and germanium. In the intrinsic range the conductivity is given by $\sigma = 1{\cdot}6 \times 10^4 \exp[-0{\cdot}064/2KT]$. The energy gap between the filled and unfilled bands

0·064 eV, does not vary significantly with temperature. The number of charge carriers is therefore given by $n_e n_h = 2{\cdot}4\times10^{31}T^3 \exp[-0{\cdot}064/KT]$ combined with the expression for electrical neutrality $n_e - n_h = n_s$ where n_s is the number of charge carriers due to the impurity atoms. In the *p*-type alloys the Hall constant reverses sign, and from the temperature of this reversal the ratio of the lattice scattering mobilities for electrons and holes can be calculated as $C = \mu_e/\mu_h = 1{\cdot}3$. In the lattice scattering range the mobilities are given by $\mu_e = 11{\cdot}6\times10^6T^{-3/2}$, $\mu_h = 8{\cdot}9\times10^6T^{-3/2}$. A.

537.311.33 : 536.212

3476. Towards the estimation of the thermal conductivity of semiconductors. A. F. IOFFE. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 3, 369–72 (1952) *In Russian.*

A short theoretical paper discussing the difficulty of calculating the thermal conductivity from available data. Formulae for the two components (lattice and electron) are examined in terms of different materials and their physical structure. W. BARDSLEY

537.311.33 : 537.312.5–15

3477. Infrared photoconductivity due to neutral impurities in germanium. E. BURSTEIN, J. W. DAVISSON, E. E. BELL, W. J. TURNER AND H. G. LIPSON. *Phys. Rev.*, **93**, 65–8 (*Jan.* 1, 1954).

Impurity photoconductivity studies have been carried out at liquid helium temperature over the range of 1 to 38 microns for *n*- and *p*-type germanium containing various donor and acceptor impurities. As expected from the thermal ionization energy data, the impurity photoconductive response of germanium containing group III or group V impurity elements extends beyond 38 microns, the limit of measurement; the response of zinc-doped germanium also extends beyond 38 microns, indicating an upper limit of 0·033 eV for zinc acceptor centres; the photoconductive response of copper-doped germanium extends only to 29 microns, indicating an optical ionization energy for copper impurity centres of 0·043 eV. An electrical "breakdown" is observed at liquid helium temperature in germanium containing small concentrations of group III or group V impurity elements which makes it necessary to use relatively low applied fields in the photoconductivity measurements. A.

537.311.33 : 537.312.7

3478. Influence of capacitatively applied fields on the conductivity of thin semiconductor layers. K. ZÜCKLER. *Z. Phys.*, **136**, *No.* 1, 40–51 (1953) *In German.*

By determining the influence of a capacitatively applied field (one electrode insulated from semiconductor) on the conductivity of thin layers of Se and Cu_2O, values are obtained for the barrier potential and thickness. To minimize and to determine disturbing relaxation effects (due to appreciable ionic mobilities) experiments are also made at −78°C and +80°C. Temperature-dependent properties, defect-centre concentrations and carrier mobility are determined. G. F. J. GARLICK

537.311.33 : 538.22

3479. The magnetic properties of semiconductors with special consideration of grey tin. I–II. G. BUSCH AND E. MOOSER. *Helv. phys. Acta*, **26**, *No.* 6, 611–56 (1953) *In German.*

Pt I is a theoretical account of the magnetic properties of semiconductors. Contributions to the total susceptibility due to (*a*) electrons in the valence band, (*b*) electrons in the conduction band and holes in the valence band and (*c*) impurity atoms, are considered separately. The susceptibility due to the free electrons and holes, treated as a Fermi gas, is calculated and leads to information on the temperature dependence of the Fermi level and on the concentrations and effective masses of the carriers. Measurements of the susceptibility with different concentration of impurity atoms are shown to yield information on the mechanism of the incorporation of such impurity atoms with the semiconductor.

Pt II contains an account of the apparatus and experimental procedure used for the determination of the magnetic susceptibility of grey tin powder containing different kinds and concentrations of impurities, and of the results obtained. The measurements were made over a range of temperature from 80°K to 300°K. From the results values are found for the activation energy of α-tin (0·08 eV) and for the ionization energies of different impurities.

A. E. DE BARR

537.311.33 : 538.632

3480. The significance of conductivity measurements on indium antimonide. O. G. FOLBERTH AND O. MADELUNG. Note in *Z. Naturforsch.*, **8a**, 673–5 (*Oct.*, 1953) *In German.*

Discusses interpretation of Hall and conductivity temperature variation. Assumes that the curved "intrinsic" region is in fact due to impurity plus intrinsic conduction. For some specimens of high purity the forbidden energy gap is estimated as 0·36 eV. C. A. HOGARTH

537.311.33 : 538.632

3481. Conductivity and Hall effect of ZnO at low temperatures. S. E. HARRISON. *Phys. Rev.*, **93**, 52–62 (*Jan.* 1, 1954).

The Hall effect and conductivity of zinc oxide have been measured in dense polycrystalline samples and two single crystals. It has been found that the usual simple Wilson semiconductor model is inadequate for the proper interpretation of results. Several modifications and additions have been suggested for the usual single-level impurity semiconductor. Allowance has been made for the polycrystalline nature of the sintered specimens in deducing the bulk properties. Three models are successful in giving the correct interpretation for the experimental results of the Hall curves. These are: (1) orbital degeneracy of electrons attached to an interstitial zinc atom; (2) additional energy levels at traps at the impurity level, where the number of traps is much greater than the number of donors; (3) traps far below the donor level that greatly outnumber the donors [this is mathematically the same as (2) but necessitates other lattice imperfections for physical realization]. Physical realization of these energy level schemes is considered in the light of the other physical properties of ZnO, such as luminescence and photoconductivity. These physical models are examined with the aid of present-day knowledge of

the alkali halides and other ionic crystals. It is found that pairs of positive (zinc) plus negative (oxygen) ion vacancies with excess oxygen ion vacancies are capable of reproducing the diversified electrical and optical properties of zinc-oxide semiconductor. The previous scheme of frozen-in interstitial zinc atoms is shown to be incompatible with the experimental results. Experiments are proposed for further verification of the proposed model. A.

537.311.33 : 621.314.7

3482. Measurement of minority carrier lifetime and contact injection ratio on transistor materials. A. MANY. *Proc. Phys. Soc.* [*London*] *B*, **67**, 9–17 (*Jan.*, 1954).

In the method described the lifetime is obtained by observing the decay of resistance of a filament throughout the duration of an injecting pulse. The use of a bridge circuit, incorporating a resistance-capacitance network which is electrically analogous to the filament, enables the lifetime to be read off a calibrated dial. The range of lifetime, which can be measured with the equipment in its present form, extends down to 1 μsec, the accuracy being usually about 5%. The method is also capable of determining minority carrier mobilities. Examples of measurements of lifetime and injection ratio of soldered contacts in *n*-type germanium are given. The injection ratio is found to rise linearly with the current through the contact. A.

537.311.33 : 621.383

3483. Cadmium sulphide cells. F. GANS. *Bull. Sci. Assoc. Ingén. Montefiore* [*A.I.M.*] **66**, 897–911 (*Nov.*, 1953) *In French.*

Reviews semiconductor theory and action of photoconductive cells, and then describes the construction and uses of CdS cells. C. A. HOGARTH

537.311.33

3484. Contribution to the knowledge of dynamic characteristics of selenium rectifiers. H. LAUCKNER. *Z. angew. Phys.*, **5**, *No.* 9, 341–9 (1953) *In German.*

Reviews and discusses the forming processes of Se rectifiers. C. A. HOGARTH

537.311.33

3485. The mode of action of the CdSe intermediate layers in selenium rectifiers. A. HOFFMANN AND F. ROSE. *Z. Phys.*, **136**, *No.* 2, 152–65 (1953) *In German.*

Series of experiments which suggest that the rectification occurs between the *n*-type CdSe and the *p*-type Se. The CdSe layer is not of sufficiently high resistance to act as an "insulating" layer.

C. A. HOGARTH

537.311.62 : 535.137

3486. The anomalous skin effect and the reflectivity of metals. IV. Theoretical optical properties of thin metallic films. R. B. DINGLE. *Physica*, **19**, 1187–99 (*Dec.*, 1953).

For Pt III, see Abstr. 1321 (1954). It is shown how the reflection, transmission and absorption coefficients of a thin metallic film may be determined theoretically when due account is taken of the anomalous nature of the skin effect. Explicit formulae are derived fo these coefficients valid in the near infrared, visible an ultraviolet, assuming diffuse electron reflection at th surfaces. The reflection and absorption coefficient are found to include a term, important for thin film at low temperatures, which is an oscillatory functio of the ratio of the minimum time for an electron t cross the film to the period of the radiation: thi suggests a promising method of measuring the electro velocity at the Fermi level. A

537.312.5

3487. Photovoltaic effect in polycrystalline sulphu under lateral irradiation. G. NADZHAKOV AN R. ANDREĬCHIN. *Izv. Bulg. Akad. Nauk*, **2**, 293–32 (1951) *In Bulgarian.*

A new photovoltaic effect in sulphur is described differing from the previously known effects by the fact that both electrodes were uniformly irradiated from one side only. The photo-p.d. resulting wa measured by electrometer the readings of which were photographed. In lateral irradiation of photo-depolarized sulphur the electrometer, after discon-nection, showed a deflection corresponding to a photo-p.d. which is a function of time. The photo-p.d of each photoelement has a value depending on the electrode material. In the evaluation the maximum values (saturation values) of the photo-p.d. were used On darkening, the formation of the p.d. stops, starts again and goes up to the maximum when irradiation continues, the potential reached is maintained in the darkness, apart from negligible leakage losses. The potential gradient with respect to time increases with optical intensity applied. There is a photo-potential series of electrode materials from negative to positive, thus: Al, Zn, Fe, Cu, Pt, Ni for which the photo-e.m.f.'s were established (for comb-type and wire-shaped electrodes), which for wire-shaped electrodes coincides with the voltaic series of contact potentials, comb-type electrodes causing some deviations from the voltaic series. Yet the photo-p.d.'s could still be proved to be intrinsically pure contact p.d.'s, so that sulphur which in darkness is an insulator and in the light a conductor simply serves as a solid electrolyte. It was possible to produce photo-elements which retained the photo-p.d. equal to the contact-p.d. in the darkness. The magnitude of this p.d. is independent of the optical wavelength used. The contact p.d. is thus the limiting value of the photo-p.d.'s obtainable; sulphur is activated as solid electrolyte by irradiation. B. F. KRAUS

537.312.5

3488. Investigation of photoelectrets. G. NADZHAKOV AND N. T. KASHUKEEV. *Izv. Bulg. Akad. Nauk*, **2**, 321–40 (1951) *In Bulgarian.*

Photoelectrets consisting of sulphur were investigated for maintenance of their photopolarization in the darkness and under the effect of depolarizing light of varying intensity and spectral composition. It was found that after storage for some time in the dark a photoelectret of ordinary sulphur shows a reduction of its general photopolarization (by the usual depolarization in the dark based on conductivity). This leads to the disappearance of the component of the "ordinary" polarization. Electrets consisting of high-purity sulphur show no diminution

of the polarization after storage up to more than 36 hr. The depolarization rate of the photoelectrets increases with the intensity of depolarizing light. U.v. polarization of photoelectrets cannot be reversed by irradiation with an ordinary incandescent lamp; it is permanent. B. F. KRAUS

537.312.5

3489. On the effects observed with elliptically polarized light acting on selectively photoelectric surfaces. A. JABŁONSKI AND S. ZIEMECKI. *Bull. internat. Acad. Polon. Sci. A, No.* 7–10, 291–301 (*July–Dec.*, 1951).

Extends and corrects earlier experiments [Abstr. 6417 (1950)]. The photoelectric current produced when light ($\lambda = 3458$ Å), elliptically polarized by means of a Nicol prism and a Soleil–Babinet compensator, falls on a Na–K liquid alloy surface was measured, and found to vary with the ellipticity. The minimum current in previous experiments was wrongly attributed to circularly polarized light [Abstr. 6417 (1950)] owing to the use of an inaccurate $\lambda/4$ plate. This paper shows that the minimum occurs for light polarized at right angles to the plane of incidence. A formula derived for the current (on the basis that the total current is the sum of currents produced by the components of the polarized light in the plane of incidence and perpendicular to it) is found to agree with experiment. The results of other experiments on the variation of current with the azimuth of plane-polarized light are shown to be in accord with the formula of Elster and Geitel (1895) if the total radiation of an Hg arc lamp is used, but not if monochromatic radiation is used. J. DUTTON

537.312.5

3490. Photocells with secondary electron multipliers. N. SCHAETTI. *Trans Instrum. Meas. Conf.*, **1952**, 192–7. *In German.*

A brief review of the characteristics of the cells available at present and an account of the results on dark-current, etc., obtained by the Zurich ETH on cells of their own design. A. H. W. BECK

537.312.5

3491. Response time of photoconductivity of lead selenide. L. SOSNOWSKI AND M. CHMIELEWSKI. *Bull. Acad. Polon. Sci. Cl.* 3, **1**, *No.* 3–4, 119–21 (1953).

Square-wave light pulses from a neon lamp illuminate the PbSe cell in synchronism with an exponential time base of variable frequency. A novel form of cathode-ray-tube presentation gives a straight line trace when the time constant of the time base equals that of the PbSe cell. Measurements indicate that the resistance, sensitivity and time constant of cells are interrelated. G. F. J. GARLICK

537.312.5

3492. Photoconductive and photovoltaic layers of lead selenide. H. CHECIŃSKA. *Bull. Acad. Polon. Sci. Cl.* 3, **1**, *No.* 3–4, 123–5 (1953).

Lead selenide layers are formed by evaporation of PbSe and 5% excess Pb (synthesized from Pb and Se *in vacuo*) *in vacuo* or in O_2 at about 0·01 mm Hg pressure, followed by exposure to O_2 at low pressure, heating to 450°C *in vacuo* and finally rapid cooling to room temperature. The most sensitive layers have conductivities of 0·01 mho.cm^{-1} and are predominantly *p*-type. Sensitivities up to 128 μV/μW.cm^{-2} are obtained with detection limit of $5{\cdot}5\times10^{-8}$ W/cm^2 and spectral range 0·5–3·6 μ. G. F. J. GARLICK

537.312.5

3493. Studies on the Cs_3Sb photo-cathode. T. SAKATA. *J. Phys. Soc. Japan*, **8**, 723–30 (*Nov.–Dec.*, 1953).

Spectral and energy distributions for external photoelectrons ejected from Cs_3Sb photocathodes were determined by the method of interchangeable emitters. Precautions were taken to secure electrically uniform surfaces. The energy distribution had a usual form for $h\nu = 2{\cdot}14$, 2·27, 2·84, 3·06, 3·39 and 3·96 eV. The results indicated that Cs_3Sb were semiconductors with a value of $\delta = 0{\cdot}2$–$0{\cdot}3$ eV. Here δ is the energy difference between the Fermi level and the top of the occupied band of energy states. The photoelectric work function (ϕ') was about $1{\cdot}8 \pm 0{\cdot}1$ eV. The work function obtained from the contact potential techniques was 1·5–1·6 eV. On the other hand, the thermionic work function was 1·3–1·5 eV, using Richardson's formula. A typical value of *m* (parameter depending both on the form of the occupied band and on the energy dependence of the photoelectric excitation probability), obtained both from energy and spectral measurements, was 1. Thermoelectric measurements showed that all samples were *p*-type. A.

537.312.5 : 535.371

3494. The photoconductivity of phosphors with varied luminescence mechanism. H. GOBRECHT, D. HAHN AND H.-J. KÖSEL. *Z. Phys.*, **136**, *No.* 1, 57–66 (1953) *In German.*

Details are given of the measurement of photoconductivity under 2537 or 3660 Å radiation of about 50 phosphors, mostly in powder form. ZnS, CdS and ZnO showed the highest photocurrents, ZnO the highest dark current. Various silicates, titanates, polysulphides, halides and tungstates gave very small photocurrents considered to be independent of the luminescence. The differences observed are correlated with the bimolecular mechanism of luminescence found in ZnS, etc., and the monomolecular process in the class of low photoconductivity. S. T. HENDERSON

537.312.5 : 535.371

3495. The influence of irradiation intensity, field strength and temperature on the dark and photocurrents of phosphors. H. GOBRECHT, D. HAHN AND H.-J. KÖSEL. *Z. Phys.*, **136**, *No.* 3, 285–92 (1953) *In German.*

See preceding abstract. Apparatus is described for the measurement of photoconductivity of powdered phosphors under radiation of 3660 Å, and at variable layer thickness and between −180 and 120°C. As intensity of irradiation increases, the photocurrent is at first proportional to intensity for ZnS.Zn (a), ZnCdS.Ag (b), and $BaPt(CN)_4.4H_2O$ (c), but Ohm's law is not obeyed. For these phosphors and for ZnO the log of photocurrent or dark current decreases linearly with increase of 1/field-strength except for low field-strengths. Phosphors with bimolecular emission processes [a, b, and CaSrS.Cu (d)] show nearly constant photocurrent up to 300°K and then an exponen-

tial rise. Monomolecular type phosphors [c and Zn_2SiO_4.Mn (e)] show different effects. The log of dark current in d, e, and Mg_2TiO_4.Mn decreases linearly with increase of 1/absolute temp., as for semiconductors generally. The results are discussed in comparison with corresponding luminescence effects.

S. T. HENDERSON

537.312.5 : 621.383.4

3496. A method of describing the detectivity of photoconductive cells. R. C. JONES. *Rev. sci. Instrum.*, **24**, 1035–40 (*Nov.*, 1953).

First it is pointed out that at signal modulation frequencies well below the frequency that corresponds to the time constant of the cell, the responsivity of the cell is independent of the frequency. For the same range of signal modulation frequencies, the noise power (mean square noise voltage) per unit frequency bandwidth is inversely proportional to the frequency. It is a very general property of radiation detectors obeying Lambert's law that the detectivity varies inversely as the square root of the sensitive area. As a result of the facts just stated, one is led to the conclusion that if one multiplies the measured detectivity by the square root of the cell's sensitive area and by the square root of the bandwidth of the noise, and if one divides by the square root of the frequency of the test signal, one obtains a result that is independent of the test bandwidth and test frequency and is independent also of the sensitive area of the cell. The detectivity $\mathfrak{D}$ so obtained is defined here and is called the "detectivity in the reference condition *C*." The detectivity $\mathfrak{D}$ is not proposed as a replacement for a detailed description of the test conditions and test results. It is an auxiliary quantity to be computed from the test results. It has the advantage over any other single test result that the knowledge of it alone permits a direct and significant comparison of two cells, even though the cells are of different area and are tested under different conditions. A discussion is included of the various auxiliary "ground rules" that must be observed if one wishes to state the detectivity of a cell with complete unambiguity. A.

537.312.6 : 539.217

Resistance of Na and K near their melting points. *See Abstr.* 3902

537.312.62

3497. Recent research on superconductivity in the U.S.S.R. D. SHOENBERG. *Nuovo Cimento*, **10**, *Suppl. No.* 4, 459–80 (1953).

A descriptive survey with bibliography (86 refs.) of work done since about 1946 under the following headings: The intermediate state; The effects of pressure on the superconducting transition, etc.; New superconducting compounds; Thin superconducting films; Measurements at radiofrequencies; Miscellaneous—the superconducting transition, thermodynamic properties, penetration depth measurements; Theoretical work.

537.312.62

3498. Kinetics of destruction of superconductivity by an alternating field ($\omega \leqslant \sim 10^6$ sec^{-1}). I. M. LIFSHITS AND M. I. KAGANOV. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 3, 363–6 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-114.*

In experiments by Lazarev and Galkin and others a steady magnetic field and an alternating one are superimposed on a superconductor so that during part of each period the field exceeds the critical value destruction of superconductivity takes place by the movement into the metal of a boundary between superconducting and normal phases. The kinetics of this process is discussed, taking into account both the possibility of relaxation effects and of superheating. The discussion is limited to frequencies <1 Mc/s, so that mean-free-path effects are unimportant, and expressions are given for the depth of the boundary as a function of time for various limiting conditions. See also Abstr. 1016 (1952). D. SHOENBERG

537.312.62

3499. Kinetics of destruction of superconductivity by a high-frequency field. I. M. LIFSHITS. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 4, 529–31 (1953) *In Russian.*

The theory of the previous abstract is extended to apply to frequencies up to 10^4 Mc/s. where mean-free-path effects are important and the conditions of the anomalous skin effect apply. D. SHOENBERG

537.312.62 : 530.14

3500. The field theory of superconductivity. A. SALAM. *Progr. theor. Phys.*, **9**, 550–4 (*May*, 1953).

Fröhlich's field theory of superconductivity is rewritten in a form in which the recent (perturbation) methods of writing down matrix elements can be readily applied. A.

537.312.62 : 548.

3501. On a correlation between the electron assembly and the lattice waves in the crystal. Y. KITANO AND H. NAKANO. *Progr. theor. Phys.*, **9**, 370–80 (*April* 1953).

The Hamiltonian of the system, consisting of the electron assembly and of the lattice ion assembly interacting with each other in the crystal, is studied by making use of a kind of a canonical transformation, called Bohm–Pines's transformation. Under an interpretation deduced from the results of this treatment, Fröhlich's theory of superconductivity is regarded as reasonable despite the important objection raised by Wentzel and others. Furthermore the approximate treatment is quite accurate in the one-dimensional case, and this fact seems to suggest that it might be tolerably good in the three dimensional case also. A.

537.312.6

3502. Some facts about superconductivity. C. J. GORTER. *Physica*, **19**, 745–54 (*Sept.*, 1953).

A brief review of the facts of superconductivity followed by discussion (Lorentz Kamerlingh Onnes Conference). D. SHOENBERG

537.312.6

3503. Superconductivity and lattice vibrations. H. FRÖHLICH. *Physica*, **19**, 755–64 (*Sept.*, 1953).

A brief discussion of the author's theory of interaction between electrons and lattice vibrations as the cause of superconductivity. It is pointed out that present methods of calculating this interaction are inadequate and a possible new approach is indicated. Followed by discussion (Lorentz Kamerlingh Onnes Conference). D. SHOENBERG

537.312.62

3504. The coherence concept in superconductivity. A. B. PIPPARD. *Physica*, **19**, 765–74 (*Sept.*, 1953).

A brief summary of the arguments leading to the coherence concept and a consequent modification of London's equations [Abstr. 4106 (1953)]. Preliminary results by Doidge on the sharpness of the superconducting transition in pure Sn and Sn–In alloys, and by the author on the variation in Sn of frozen-in flux with In content, are also reported. Followed by discussion (Lorentz Kamerlingh Onnes Conference).

D. SHOENBERG

537.312.62

3505. Low-temperature diamagnetism of electrons in a cylinder. R. B. DINGLE. Letter in *Phys. Rev.*, **92**, 1320 (*Dec.* 1, 1953).

Criticisms of calculations by Band [Abstr. 6805 (1953)] suggesting that these are based on invalid approximations and a reply to Band's objections to Dingle's use of the WKB method [Abstr. 3421 (1953)].

D. SHOENBERG

537.312.62

3506. An attempt to find anisotropy in the superconductive properties of gallium. A. J. CROFT, J. L. OLSEN-BAER AND R. W. POWELL. *Phil. Mag.*, **45**, 123–5 (*Feb.*, 1954).

Gallium has a marked anisotropy in its electrical resistivity; these experiments, which cover the temperature range 0·2°K to 1°K, show that any dependence of superconductive transition point on crystallographic direction is less than $\sim 0{\cdot}002$°K. A.

537.312.62 : 536.212.2

3507. Thermal conductivity of superconductors. K. MENDELSSOHN. *Physica*, **19**, 775–87 (*Sept.*, 1953).

A review of experimental data on thermal conductivity of superconductors including new results by the author on single crystals of Pb, Sn and In and polycrystalline Tl below 1°K. Followed by discussion (Lorentz Kamerlingh Onnes Conference).

D. SHOENBERG

537.312.62 : 536.212.2

3508. Short communication on thermal conductivity of superconductors. D. SHOENBERG. *Physica*, **19**, 788–90 (*Sept.*, 1953).

A contribution to the discussion (see preceding abstract) reporting some experiments by Laredo on single crystals of pure Sn and an alloy with 3% In, which emphasize the importance of eliminating frozen-in flux in such measurements. D. SHOENBERG

537.315

3509. On the vector potential of surface currents. P. BAUDOUX. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 7, 636–9 (1953) *In French.*

The conservation of the vector potential (zero divergence) is demonstrated, subject to the surface current not extending to infinity. L. S. GODDARD

537.32

3510. The anisotropy of the absolute thermoelectric e.m.f. of tin between 0° and 280°C. F. CIRKLER. *Z. Naturforsch.*, **8a**, 646–59 (*Oct.*, 1953) *In German.*

The preparation, and measurement of the e.m.f.'s against Pt 10% Rh, of eight single crystals of orientations $11\frac{1}{2}$–86° and one polycrystal are described in detail. The apparatus is shown schematically. The single-crystal rods were 15–25 cm long and were prepared by seeding and slow cooling from the melt. The variation with temperature, t, of the e.m.f.'s is shown graphically and expressions in the form $at + bt + ct^3$ are derived for the e.m.f.'s and absolute e.m.f.'s, e. The anisotropy $(e_{||} - e_{\perp})/e_{45°}$ is 4% at the melting point and the change in thermoelectric power $1{\cdot}6\ \mu$V/deg.c. The results are compared with those of previous investigators. The theories of Sommerfeld–Bethe and Kohler on the dependence of e.m.f. on purity and orientation are discussed and it is shown that the author's results deviate more from Voigt's cosine^2 law than the theories suggest.

S. WEINTROUB

ELECTRIC DISCHARGES 537.52

537.52

3511. Measurement of the velocity of shift of the main channel in a high-voltage discharge. I. S. STEKOL'NIKOV. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 5, 1013–16 (1952) *In Russian.*

Develops a method of determining the velocity of the front portion of the main channel with the aid of an electro-optical shutter (polarizer/Kerr-cell/analyser). The analysis of more than 150 oscillograms and photographs shows for the system positive-rod/negative-plate that (1) the visible main channel is formed at the moment in which the current in the oscillogram $[i = f(t)]$ suddenly increases; (2) the current reaches its maximum when the front of the channel reaches 35–50% of the discharge gap (reckoned from the plate); (3) the front of the channel reaches the rod electrode simultaneously with the transition of the impulse of the channel current into the current of the arc phase; and (4) the maximum velocity of the front of the channel attains 16×10^8 cm/sec, falling off to 3×10^8 cm/sec when the real length of the channel current becomes $l_k = 140$ cm.

F. LACHMAN

537.521.6 : 621.315.61 : 621.3.015.5

3512. Discharge inception and extinction in dielectric voids. H. C. HALL AND R. M. RUSSEK. *Proc. Instn Elect. Engrs II*, **101**, 47–54 (*Feb.*, 1954).

Measurements of the voltage required to produce discharges in voids within a number of different dielectrics show that the discharge-inception voltage across the void is independent of the nature of the dielectric and of the void position, including the case in which the void is bounded by one of the electrodes, but depends upon void depth or thickness in the direction of the applied electric field. The measurements, including those made at pressures and temperatures other than n.t.p., are consistent with Paschen's law for metal-to-metal breakdown of gas. A.

537.523.5

3513. The stabilization of the luminous arc between anode and cathode. G. ECKER. *Z. Phys.*, **136**, *No.* 1, 1–16 (1953) *In German.*

A theoretical discussion of the discrepancies

between the author's contraction theory of the cathode region of an arc [Abstr. 8879 (1952)] and experimental results. C. G. MORGAN

537.523.5

3514. The electron density and temperature in the column of a high-current carbon arc. H. MAECKER. *Z. Phys.*, **136,** *No.* 2, 119–36 (1953) *In German.*

Electron density and excitation temperature measurements were made, using various spectroscopic methods, for carbon arcs at currents of some hundreds of amps. Radial variations of electron density were made by measuring Stark widths of H_β and the recombination continuum intensity, with excellent agreement. Max. temps. of ~11 000°c were measured. Reference to the structure of the arcs is made in detail. J. D. CRAGGS

537.523.5

3515. On the thickness of the anode fall region in a carbon arc. M. J. BLOCK AND W. FINKELNBURG. Note in *Z. Naturforsch.*, **8a,** 758 (*Nov.*, 1953) *In German.*

Briefly describes measurements made on the anode fall region by means of a moving probe technique. The probe was moved through the arc with a pneumatic device. J. D. CRAGGS

537.525

3516. Extension of the theory of the low pressure positive column. I. E. H. LUDWIG. *Z. angew. Phys.*, **5,** *No.* 10, 377–86 (1953) *In German.*

Theoretical study of the positive column as a system of electrons, photons and atoms exchanging energy which is supplied by the acceleration of electrons in the electric field. From considerations of the effective probability of collisions between electrons and atoms, and the mean life of charge carriers and excited states, expressions are derived for the occupation of an excited state, the intensity of a spectral line, the electron temperature and the longitudinal gradient in a plasma. The voltage/current characteristic is obtained, and it is also shown that there is a limit to the existence of a plasma at very low pressures. J. DUTTON

537.525

3517. Extension of the theory of the low pressure positive column. II. E. H. LUDWIG. *Z. angew. Phys.*, **5,** *No.* 11, 421–6 (1953) *In German.*

Comparison of theoretical results for the wall current, the electron temperature, the longitudinal gradient and spectral radiation in a Hg vapour discharge, calculated on the basis of the theory given in Pt I, with previous experimental results [Abstr. 2521 (1949)]. J. DUTTON

537.525 : 537.534.3

3518. Mass spectral investigation of "active" nitrogen. D. S. JACKSON AND H. I. SCHIFF. Letter in *J. chem. Phys.*, **21,** 2233–4 (*Dec.*, 1953).

Briefly describes observations of N^+ and N_2^+ in pure nitrogen afterglows (~1 mm Hg pressure) using a continuous flow method. J. D. CRAGGS

537.525.3 : 537.525.72 : 537.525.8

3519. Non-variant nature of field gradient under irradiation causing Joshi effect in a.c. electric discharge. M. G. BHATAWDEKAR, O. P. DOGRA AND N. A. RAMAIAH. Letter in *Curr. Sci.*, **22,** 335–6 (*Nov.*, 1953).

Reports indirect measurements of the electric fie in electrodeless corona (Joshi) discharges, which a discussed in relation to space-charge effects.

J. D. CRAG

537.525.4 : 537.531 : 621.386

3520. High-vacuum breakdown and its applicati to X-ray flash tubes. E. FÜNFER. *Z. angew. Phys.*, *No.* 11, 426–40 (1953) *In German.*

The paper gives a lengthy account of work o high-vacuum breakdown, including a discussion the Trump–Van de Graaff criterion. The mechanism of current build-up are then discussed with a theor tical treatment, The experimental part of the pap deals with a detailed investigation of the behavio of flash X-ray tubes. Measurements include voltag time, X-ray output/time, and light/time oscillogram X-ray pulses may be as short as about 2 μsec.

J. D. CRAG

537.525

3521. Striated high-frequency discharge. KH. A DZHERPETOV AND A. A. ZAĬTSEV. *Dokl. Aka Nauk SSSR*, **89,** *No.* 5, 825–8 (1953) *In Russia* English translation, *U.S. National Sci. Found. NS tr*-119.

Describes striated discharges in neon or argo (pressure ~1 mm Hg) at frequencies ~10^8 to 10^9 c using either internal or external electrodes. Th striations may be apparently stationary or movin Mechanisms are not discussed. J. D. CRAGG

537.525

3522. On the theory of striae in gaseous discharg M. F. SHIROKOV. *Dokl. Akad. Nauk SSSR*, **8** *No.* 5, 837–40 (1953) *In Russian.* English translatio *U.S. National Sci. Found. NSF-tr*-128.

Equations relating the distance between striatio ("periods") to the tube diam., and the electro diffusion coefficient, etc., are derived. Exptl. valu of the period in various conditions, and obtained b other authors, are in agreement with the theor Thirteen references are given. J. D. CRAGG

537.525

3523. Production of Joshi effect under high fr quency electric discharge in iodine vapor. M SUBRAHMANYAM AND N. A. RAMAIAH. Letter *J. chem. Phys.*, **21,** 2233 (*Dec.*, 1953).

Describes ozonizer tube discharges in iodi vapour at frequencies varying from 0·1–10 Mc/s.

J. D. CRAG

537.525

3524. The transition from free to ambipolar diffusio W. P. ALLIS AND D. J. ROSE. *Phys. Rev.*, **93,** 84–9 (*Jan.* 1, 1954).

In gas discharge plasmas with very low char densities, the charged particles diffuse freely directions perpendicular to the applied electric fie because the space-charge field is negligible. At hig charge densities, the space-charge field saturates a gives rise to a combination of diffusive and mobili flow termed ambipolar. The transition between the limits is examined theoretically for the case of plasma maintained through ionization by electron impac

The ionization frequency per electron, one of the principal parameters of the transition, can be re-expressed in terms of an effective diffusion coefficient; it falls from a high value at the free-diffusion limit to a low value at the ambipolar limit as the electron density increases over many orders of magnitude. The transition is accompanied by changes in the charge distributions and by the development of a positive-ion sheath. The current equations determining the process are examined, and approximate solutions are obtained. Second approximations are obtained for the case where the ratio of electron to ion energies is much greater than unity. Machine solutions are presented both for the above case and for an isothermal plasma in which this ratio equals unity. An application to the afterglow is shown. A.

537.525.8

3525. Streamer mechanism in a.c. silent discharges. S. R. KHASTGIR AND C. M. SRIVASTAVA. *Indian J. Phys.*, **27**, 109–17 (*Feb.*, 1953).

The streamer mechanism of Loeb and Meek (1940), as applied to a.c. "silent" discharges is developed. According to the streamer theory, when the applied field is adequate for Townsend's cumulative ionization, there is a conical column of positive ions drifting towards the cathode. In an a.c. "silent" discharge, the negative charge formed on the intervening glass surface attracts the positive ions of the conical column near the anode and forms a stationary array of positive ions close to the glass surface, producing thereby an electrical double layer. A gap is also set up initially between the array of positive ions and the streamer by the time the latter touches the glass wall on the cathode side. A discharge is not, therefore, possible at the time due to this gap. It is explained how this gap is subsequently bridged up, when the density of the charge on the glass surface attains a requisite value producing what have been called Townsend pulses at the peak values of the applied a.c. field. The discharge (or discharges) across the electrical double layer on and near the glass surface in the manner suggested by Mitra gives rise to a different type of pulses. Such pulses are called discharge pulses. That the two types of pulses exist, at least in certain gases, is substantiated by the experimental results of Khastgir and Setty. In iodine vapour, there is experimental evidence to show that the critical voltage for the occurrence of the Townsend pulses is distinctly less than that for the occurrence of the "discharge" pulses. The effect of light on the two types of pulses is considered in detail and the following conclusions are drawn: (i) Initiation of the Townsend pulses by irradiation may be possible under favourable conditions. This explains the positive Joshi effect observed near the threshold potential in certain gases. (ii) At or near the "threshold" potential, complete suppression or reduction of either type of pulses may be caused by irradiation. (iii) In iodine vapour, the negative light effect is largely due to the disappearance or reduction of the "discharge" pulses. A.

537.525.8 : 538.561

Self-excitation of the oscillations in the positive column of the gas discharge. *See Abstr.* 3677

537.525.8 : 538.565

3526. The dispersion formula for plasma waves. L. R. WALKER. Letter in *J. appl. Phys.*, **25**, 131–2 (*Jan.*, 1954).

Discusses the solution of the Bohm–Gross wave equations, for plane longitudinal small-amplitude waves in a plasma. J. D. CRAGGS

537.525.92

3527. The decay of the space charges in intermittent discharges in neon and argon. D. BRINI AND P. VERONESI. *Nuovo Cimento*, **10**, 1662–72 (*Dec.*, 1953).

The influence of the gas pressure and of the distance of the electrodes on the process of the decay of space charges in intermittent discharges in neon and argon is examined. The decay times appear in both gases to be of the order 10^{-3} sec, and are, for the distances and pressures examined, sensibly proportional to the pressure. The possible causes of the high values of such times are discussed, and the various parts of the static characteristic of a discharge tube are related to the functioning of counters and periodic discharges of the 1st and 2nd kind, which might there exist. A.

537.527.5

3528. Radiation from a high-power, high-pressure xenon arc. I. Experimental results for luminous radiation. K. LARCHÉ. *Z. Phys.*, **136**, *No.* 1, 74–86 (1953) *In German.*

Experimental determination of the energy and radiation distribution, arc temperature and dependence of light output on power input. C. G. MORGAN

537.527.5

3529. Radiation from a high-power, high-pressure xenon arc. II. Theoretical basis for determining the plasma temperature and applications. H. SCHIRMER. *Z. Phys.*, **136**, *No.* 1, 87–104 (1953) *In German.*

A detailed theoretical discussion of the radiation emitted with reference to the absorption of the radiation, its dependence on temperature and the energy and temperature distribution in a short arc. The efficiency of a water-cooled arc lamp is considered. C. G. MORGAN

537.528/.529

3530. Breakdown of dielectrics. YA. I. FRENKEL'. *Zh. eksper. teor. Fiz.*, **23**, *No.* 6, 619–25 (1952) *In Russian.*

A further generalization of the author's and Plumley's views [*Zh. eksper. teor. Fiz.*, **8**, 1292 (1938); *Phys. Rev.*, **59**, 200 (1941)] that the effect of the applied field on the electrical conductivity of solid and liquid dielectrics can be explained by a decrease of energy of ionization of particles. Attention is also paid to another possible reason for the increase of conductivity, namely a Schottky surface effect, resulting in the flooding of the insulator with electrons from a hot cathode. R. C. MURRAY

537.529

3531. Statistical time lag and electron avalanche in dielectric breakdown of mica. II. H. KAWAMURA AND M. ONUKI. *J. Phys. Soc. Japan*, **8**, 731–3 (*Nov.–Dec.*, 1953).

For Pt I, see Abstr. 8231 (1952). The sizes of elec-

tron avalanches were measured by noise pulses just before the disruption of mica. Because the breakdown does not occur at the instant of the application of the transient overvoltage, owing to the statistical time lag, the number of the noise pulses during the interval from the instant of the application of the voltage to the instant of the disruption could be counted, and was about 10^{-2} sec. Measuring the distribution of the noise, the authors have estimated the avalanche size just sufficient to cause the disruption to be 10^8 electrons. A.

X-RAYS 537.531

537.531 : 535.33.07

3532. Construction of a spectrograph for soft X-rays of wavelength 2 to 20 Å. *L* emission spectra of wavelength 9 to 14 Å. J. MORLET. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 2, 205–16 (1953) *In French.*

A curved-crystal vacuum spectrograph is described. There is no window between X-ray tube and spectrograph, and electrons from the filament are electrostatically deflected along a curved channel to the target, so that light from the filament does not fog the film. The *L* spectra of zinc and copper were investigated, both separately and in an alloy. The spectrum of copper is slightly different in the alloy.

A. R. STOKES

537.531 : 535.338

3533. Mo *K* and U *L* X-ray transitions from separated isotopes. G. L. ROGOSA AND G. SCHWARZ. *Phys. Rev.*, **92**, 1434–7 (*Dec.* 15, 1953).

The $K\alpha$ ($K \rightarrow L_{III}$, $K \rightarrow L_{II}$) X-ray lines of Mo and the $L\beta_1$ ($L_{II} \rightarrow M_{IV}$) and $L\alpha_1$ ($L_{III} \rightarrow M_V$) X-ray lines of U have been measured from separated isotopes using a double-crystal X-ray spectrometer. The X-ray transitions were induced by radiative excitation from a W target X-ray tube. Intensities were measured with a 70-cm Kr-filled Geiger counter. No evidence of nuclear isotopic effects (hyperfine structure and isotope shift) on the X-ray levels was found in the measurement of these transitions. The $K\alpha$ transitions from the separated isotopes Mo^{92} (95·5%), Mo^{95} (88·0%) and Mo^{100} (86·65%) in MoO_3 and the $L\beta_1$ and $L\alpha_1$ transitions from the separated isotopes of U^{235} and U^{238} in U_3O_8 show no measurable shift in peak positions and no changes in line widths. The limit of an observable effect is 0·2 V for the Mo transitions and 0·4 V for the U transitions. A.

537.531 : 535.343

3534. X-ray absorption fine structure with polarized X-rays. R. KROGSTAD, W. NELSON AND S. T. STEPHENSON. *Phys. Rev.*, **92**, 1394–6 (*Dec.* 15, 1953).

The fine structure on the short-wavelength side of the *K* X-ray absorption edge of Cl in single crystals of NaCl and KCl has been studied with polarized X-rays in a vacuum double-crystal spectrometer. The structure was obtained when the main direction of ejection of photoelectrons was perpendicular to a set of 100 planes and again when perpendicular to 110 planes. One significant difference in structure was noted for the two different directions of ejection in the case of NaCl. A.

537.531 : 535.

3535. Studies of solutions of halides and nitrates zinc and cadmium by means of X-ray diffracti ($\lambda = 0{\cdot}71$ Å). F. DEBOT. *Bull. Soc. Roy. S Liège*, **22**, 310–16 (*June–July*, 1953) *In French.*

In an earlier paper the author described the scatte ing curves obtained with Cu $K\alpha$ radiation, and has now examined the same solutions with Mo $K\alpha$ radiation. Fluorescent radiation seriously interfer with the scattering experiments when the solutio contain zinc or bromine but the effect is much le troublesome with the other elements used. Filteri the scattered beams with nickel foils is of considerab assistance except in the case of bromides for whi the scattering curves are almost useless. The curv obtained are very similar to those obtained wi Cu $K\alpha$ except that the first maximum on the latt curves has merged into the region of the direct bea in the case of Mo $K\alpha$. J. IBA

537.531 : 535.42 : 778.

Microradiography and micro X-ray diffractio *See Abstr.* 2999

CATHODE RAYS . POSITIVE RAYS 537.533/.5

537.533.3 : 535.327

3536. The sensitivity of simple electron-optic schlieren apparatus. W. ROLLWAGEN AND SCHWINK. *Optik*, **10**, *No.* 11, 525–30 (1950) *German.*

The paper discusses the schlieren method measuring small amounts of magnetization in specimen by observing its shadow image formed a fluorescent screen by means of a magnetic len The important factors are the geometry of the syste the spherical aberration of the lens, and the accele ting voltage. Using the optimum values, a sens tivity of 0·3 gauss.cm is obtainable with only o lens. Further work in progress promises a sensitivi of 2×10^{-2} gauss.cm. A.E.I. RESEARCH LABORATO

537.533.

3537. The aberration constants of an electro optical imaging system without aperture. W. GLAS AND H. GRÜMM. *Österr. Ingen. Arch.*, **6**, *No.* 360–72 (1952) *In German.*

As it is usual in electron microscopy not to emplo an objective aperture, the earlier derivation aberration coefficients for an apertured syste [Glaser, *Z. Phys.*, **83**, 104 (1933)] is here extended t the apertureless system. The expressions obtaine are used in conjunction with numerical values for th coefficients of the apertured system, repeated here i full, to obtain tables and graphs of values for th coefficients of the apertureless system for variou values of the lens strength parameter, k^2. Values a also given for the separation of the cusps of the caustic (the astigmatic difference) and the distance of th mid-point between the cusps from the Gaussian imag plane. The results are used to evaluate the effe upon the lens resolving power of a misalignment o

e imaging beam. Numerical values are given at veral aperture angles for varying degrees of de- ntration. V. E. COSSLETT

537.533.332

538. Image aberrations due to asymmetry in magnetic) electron lenses. W. GLASER AND P. CHISKE. *Z. angew. Phys.*, **5**, *No.* 9, 329–39 (1953) *In erman.*

The astigmatic aberrations arising from geometrical symmetry of the polepieces of magnetic lenses are eated for the most general conditions. Lack of otational symmetry in the bore, lateral displacement nd inclination of one polepiece with respect to the ther are all discussed. Equations are set up for he form of the polepiece surfaces in the disturbed onditions. The boundary value problem is solved y using an expression for the axial potential within he polepieces due to Bertram [*J. appl. Phys.*, **13**, 496 1942)]. The departure from rotational symmetry of he magnetic field, in function of the ratio of bore to olepiece gap, is then found by Fourier transforma- on. The astigmatism coefficients follow from the xial distribution of the disturbed field. Tables of hese coefficients are given for various values of ore/gap ratio and of an excitation parameter. Numerical comparison is made with the results btained for a special type of magnetic lens by turrock [Abstr. 7008 (1951)] using a different method f calculation. V. E. COSSLETT

537.533.35

539. A new Trüb–Täuber electron microscope. . WEGMANN. *Trans Instrum. Meas. Conf.*, **1952**, 3–83. *In German.*

The electron microscope previously described Wegmann, *Chimia*, **4**, 26 (1950); *Optik*, **7**, 263 1950)] has been re-designed to give higher resolving ower and greater flexibility of operation. The chief hange is the introduction of an intermediate pro- ection lens, to give three stages of magnification. his lens and the objective are electrostatic, whereas he condenser and final projector are magnetic lenses. All the lenses are mounted on parts of the microscope olumn so that they can readily be removed for clean- ng and adjustment. To allow a large enough cross- ection of column for low magnification images and or electron diffraction, the two projector lenses are o mounted that they can be rotated out of the elec- ron beam at will and returned again to the same xial position. A focusing aid is provided, in the orm of a condenser diaphragm with three apertures; when focusing, the object is illuminated by a triple eam, of large angular aperture, but for photography y a single beam of small aperture. The cold cathode s retained as electron source, but in the form of a teel disk instead of an aluminium rod, in the interests f stability. Voltages of 30, 45 and 50 kV are sup- lied from the high tension set. The camera contains 2 plates of size 6×9 cm. A molecular pump is used s high vacuum pump. Objective apertures of three izes are provided, which can be interchanged and entred during operation. The standard instrument s claimed to give better than 50 Å resolution, and some f the micrographs shown probably approach 30 Å. V. E. COSSLETT

537.533.35

3540. Magnetic beta spectrograph with long lens. M. MLADJENOVIĆ. *Bull. sci. Cons. Acad. Yougoslavie*, **1**, 12–13 (*Jan.*, 1953) *In French.*

A new magnetic beta spectrograph of the lens type is described. Excitation is obtained by four coils of copper tube, cooled by water flow, and passing a current of 100 amperes. Spherical aberration is minimized by making the end coils stronger than the centre ones. To determine the positions for the limiting diaphragms, the radioactive source is replaced by an electron gun adjustable in axial position. A fluorescent screen at the output is also adjustable in position. With a solid angle of transmission of 4¼%, a resolving power of 0·46% is obtained for a source 2 mm in diameter. M. E. HAINE

537.533.73 : 531.713

3541. The effect of the finite light sources of measuring instruments on the determination of electron diffraction ring radii. G. D. ARCHARD. *Brit. J. appl. Phys.*, **5**, 69–71 (*Feb.*, 1953).

The presence of diffuse background is known to displace the intensity peaks of electron diffraction rings. The form of the necessary correction is modified by the finite dimensions of the slits which constitute the effective light sources used in the measuring instruments. It is shown that a simple form of correction is restored when the position-determining and intensity-measuring instruments have the same sized slits. A.

537.533.73 : 548.74

3542. High-angle Kikuchi patterns. M. N. ALAM, M. BLACKMAN AND D. W. PASHLEY. *Proc. Roy. Soc. A*, **221**, 224–42 (*Jan.* 21, 1954).

A cylindrical specimen chamber and camera were used to study the high-angle Kikuchi patterns obtained by reflection of electrons, of energy 6 to 50 keV, from the cleavage surfaces of crystals with the sodium chloride structure. Angles of scattering ranging from 0 to 164° were covered. The relative intensity of the pattern at different scattering angles was measured using a photographic technique. The intensity distribution was found to become less steep as the energy of the incident electrons decreased. In photographs taken with a large value of the glancing angle of incidence, defect bands were found, starting near the shadow edge of the pattern; these changed to excess bands at higher angles of scattering. The most striking feature of the results is the remarkable intensity and clarity at the highest scattering angles of the pattern produced by crystals such as lead sulphide and potassium iodide, the constituents of which have a relatively high elastic scattering cross-section. In marked constrast, a relatively low intensity and low clarity was found at these angles for lithium fluoride under the same experimental conditions. An investigation of the width of Kikuchi bands, visible over the whole available angular range, showed that the electrons forming these bands had the same energy as that of the incident electrons within the experimental error of 10%. A possible mechanism is discussed by means of which electrons can be diffused through large angles with high efficiency, relative to small angles, and with relatively little loss of energy. A.

537.533.74

3543. Dependence of electron scattering on the atomic number. B. K. Vaĭnshteĭn. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 6, 1239–42 (1952) *In Russian.*

Calculates and graphs the scattering of fast electrons for the elements with $Z = 1 \ldots 18$, taking into account the electronic shells. For large values of $\sin\theta/\lambda$, the scattering varies in the same sense as Z. For small $\sin\theta/\lambda$ values, and for $f_{el}(0)$, the scattering decreases as Z increases within a period; this phenomenon is explained. The magnitude $f_{el}(0)$ $[= 2(\pi me/h^2)V]$ indicates, in the electron-diffraction phenomena, the relative detectability of atoms in crystals. The "coefficients of detectability" thus calculated are: for H, 1; C, 4·3; N, 3·6, and O, 3·1. The magnitude V (the "overall" potential of an atom) is discussed and calculated; it agrees fairly with the experimental data obtained for the average lattice potentials. F. LACHMAN

537.533.74

3544. Generalized variational equations for the scattering of electrons by hydrogen atoms. M. M. Gordon and J. G. Jones. *Phys. Rev.*, **92**, 1428–32 (*Dec.* 15, 1953).

Generalized variational equations are derived for calculating the elastic and inelastic scattering amplitudes associated with the scattering of electrons by hydrogen atoms. The derivation of these equations is such that no unnecessary restrictions are imposed on possible trial wave functions. Two equivalent formulations are given: one involving the use of symmetrized wave functions; the other involving wave functions of the conventional (Mott and Massey) type. For trial wave functions consisting of only the incident wave (multiplied by a hydrogen eigenfunction), these variational equations yield the same results as are obtained by the approximations of Born and Oppenheimer. Various calculation procedures are discussed. In an appendix, it is shown that the Hulthèn variational equation for the scattering phases is a special case of the Kohn variational equation for the scattering amplitude. A.

537.533.74

3545. Positron-electron differences in energy loss and multiple scattering. F. Rohrlich and B. C. Carlson. *Phys. Rev.*, **93**, 38–44 (*Jan.* 1, 1954).

The Bhabha cross-section for positron-electron scattering is used to derive the average rate of collision loss by positrons passing through matter, which differs from the corresponding expression for negative electrons by a few per cent. The spin and exchange terms of the Bhabha and Møller cross-sections produce small corrections also in the Landau distribution of energy losses by positive and negative electrons in thin foils, the most probable energy loss being less affected than the shape of the distribution. Positron-electron differences in the average cosine of the multiple-scattering angle, and in the penetration depth at which the particles have lost their memory of initial direction, are calculated from the appropriate elastic cross-sections; the difference in rate of energy loss is included in the calculation. Numerical examples for Al and Pb are given. A.

537.533

3546. Multiple scattering of relativistic electron L. V. Spencer and C. H. Blanchard. *Phys. Re* **93**, 114–16 (*Jan.* 1, 1954).

The Goudsmit–Saunderson sum for the multi scattering of fully relativistic electrons is evaluated the conditions of an experiment of Hanson and collaborators. The results are consistent with the of Molière and Bethe but lie below the experimen points by as much as 15% at large angles.

537.533.74 : 537.534.74 : 539.164.74 : 539.1

3547. Inelastic collisions and the Molière theory multiple scattering. U. Fano. *Phys. Rev.*, **9** 117–20 (*Jan.* 1, 1954).

The effect of inelastic collisions is often introduc in the Molière theory by replacing Z^2 with $Z(Z +$ It is pointed out that this procedure relies on the i plied incorrect assumption that elastic and inelas collisions have the same small-angle cut-off. Taki into account separately the cut-off of inelastic c lisions, the Molière theory is shown to require t following modifications: (*a*) for incident electrons, place Z^2 with $Z(Z + 1)$ and increase the Molière by $(Z + 1)^{-1}\{\ln[0{\cdot}160Z^{-\frac{2}{3}}(1 + 3{\cdot}33Ze^2/hv)] - u_{in}$ where $-u_{in}$ is defined as an integral over the incohere scattering function whose value is about 5; (*b*) fl incident heavy particles, leave Z^2 unaltered but i crease b by $Z^{-1}\{\ln[1130Z^{-4/3}(c^2/v^2 - 1)^{-1}] - u_{in}$ $\frac{1}{2}v^2/c^2\}$.

537.533.74 : 778.

3548. A method for the measurement of multip scattering. H. Överås. *Phil. Mag.*, **45**, 158– (*Feb.*, 1954).

A new method for the determination of the multip scattering of short, highly scattered discontinuo tracks in nuclear emulsions, e.g. from electrons ne the minimum ionization, is described.

537.533.75 : 778.

Ionization loss at relativistic velocities in nucle emulsion. *See Abstr.* 3003

537.533.79 : 621.373.423 : 621.385.16.029

3549. Movement of an electron in a magnet undulator. R. Combe and M. Feix. *C.R. Acad. S* [*Paris*] **237**, 1318–20 (*Nov.* 23, 1953) *In French.*

Gives calculations leading to the trajectory a mean velocity gained in a complete period for ele trons in an undulator with sinusoidal magnetic fie distribution. The result for the velocity gain $\bar{\beta}/\beta = \pi/2K$, where $\bar{\beta} = \bar{v}/c$, $\bar{v}$ = mean veloci gain, $\beta = v/c$, K = complete elliptic integral of th first kind, argument $(\gamma\beta\, ct)$, $\gamma = 2\pi/l$, l = distan between poles of same sign. A. H. W. BE

537.533.9 : 535.241.

A standard light source of very low intensity bas on the Čerenkov effect. *See Abstr.* 3253

537.533.9 : 537.22

3550. The Čerenkov effect and the dielectric co stant. S. M. Neamtan. *Phys. Rev.*, **92**, 1362- (*Dec.* 15, 1953).

A quantum-mechanical theory of the Cherenko radiation is developed wherein the refractive mediu is treated not as a continuum but as an aggregati

atoms. The atoms and the electromagnetic field e considered as forming a single system which teracts with an incident charged particle. The herenkov radiation arises in first-order transitions duced by this interaction. The nature of this pro- ss suggests a quantum-mechanical definition of the electric constant with the aid of which the theory elds the well-known properties of the Cherenkov diation. The definition of the dielectric constant is own to lead to the same expression for this quantity is given by the Kramers–Heisenberg dispersion rmula. A.

537.533.9 : 537.591.15

Three-dimensional theory of electron-photon showers. *ee Abstr.* 3631

537.534

551. Periodic ellipse of the strong-focusing equation. . C. CARLSON. Letter in *Phys. Rev.*, **92**, 839 (*Nov.* 1, 953).

The equation implies that a representative point in hase space moves on an ellipse of constant area hose eccentricity and orientation are periodic nctions of the independent variable. These func- ons are obtained and displayed graphically for the se of piece-wise uniform focusing field. Differential quations of motion of the ellipse are given for the eneral case. J. S. BELL

537.534 : 533.5

552. Vacuum seals for continuously evacuated ccelerator tubes operating in high ambient pressures. . J. MIRANDA AND W. M. JONES. Letter in *Vacuum*, , 259–62 (*July*, 1952) [*Publ. Sept.*, 1953].

A method of sealing accelerator tubes with a onding resin is reported. Test results showed that nless the resin is protected from electrical discharges n the vacuum, these discharges cause the formation f carbon tracks. A design of seal which gives such rotection is described. F. J. MIRANDA

537.534 : 537.221

Electrostatic accelerators at the University of renoble. *See Abstr.* 3424

537.534 : 537.533

553. Survey of electrostatic generators. E. S. HIRE. *Brit. J. appl. Phys. Suppl. No.* 2 [*Static lectrification*] S 56–S 60 (1953).

The principles and practical points important in he design of an efficient h.v. electrostatic generator re described. The special features required for their se in nuclear physics, for X-ray production in edicine and industry, and for sterilization of food nd chemicals are considered. A.

537.534 : 621.319.3 : 621.316.7.22.9

554. Note on the voltage stabilization of an electro- tatic generator. D. R. CHICK. *Brit. J. appl. Phys. uppl. No.* 2 [*Static electrification*] S 61 (1953).

A multiple-loop servo-system is used to control nd measure the energy of an ion beam from a 00 kV electrostatic generator to 1 part 10^3. A odulated electron beam is used to provide fast orrection of the generator potential over a range of 150 kV. With 15 μA of control electrons, the -ray intensity in the target room is increased from ·07 r per 8 h to 0·10 r per 8 h. A.

537.534 : 621.384.612

3555. The Cosmotron—A review. M. H. BLEWETT. *Rev. sci. Instrum.*, **24**, 725–37 (*Sept.*, 1953).

A description of the Brookhaven Cosmotron is followed by a résumé, component by component, of its design. The necessary dovetailing in the construction is outlined in a chronology of the fabrication, assembly, and testing of the units. A summary of the preliminary operation of the accelerator includes injection and acceleration tests. In an appendix, figures on personnel are included with a table of the basic parameters of the Cosmotron. See following 26 abstracts. A.

537.534 : 538.1 : 621.318.3 : 621.384.612

3556. Magnet. I. Design. J. P. BLEWETT, M. H. BLEWETT, G. K. GREEN, W. H. MOORE AND L. W. SMITH. *Rev. sci. Instrum.*, **24**, 737–42 (*Sept.*, 1953).

The magnet of the Cosmotron is designed to provide magnetic fields up to 14 000 gauss over a region roughly 9 in. by 30 in. surrounding the proton orbit of 30 ft radius. The magnet is C-shaped with the magnetic return inside the proton orbit. The magnet gap contour is shaped very precisely to accommodate and control the excursions of the proton beam from its stable orbit. The magnet is energized by current supplied to its water-cooled coil from a 26 MVA motor-flywheel-generator set. Magnet parameters are tabulated, and the considerations which led to their choice are discussed. A.

537.534 : 538.08 : 621.317.4 : 621.384.612

3557. Magnet. II. Magnetic measurements. G. K. GREEN, R. R. KASSNER, W. H. MOORE AND L. W. SMITH. *Rev. sci. Instrum.*, **24**, 743–54 (*Sept.*, 1953).

Techniques have been developed for the precise measurement of magnetic field shapes of both steady-state and time-varying fields. A series of measurements was used to refine the design of the Cosmotron magnet and to examine the effects on field shape of many parts of component equipment. Measurements of the fields of the Cosmotron magnet have been made in detail; they indicate a field shape that conforms to the design requirements. Measurements on the magnet show good agreement with model predictions. A.

537.534 : 538.1 : 621.318.3 : 621.384.612

3558. Magnet. III. Mechanical design, fabrication and erection. R. A. MEYER AND W. H. MOORE. *Rev. sci. Instrum.*, **24**, 755–9 (*Sept.*, 1953).

The mechanical details of the structure of the Cosmotron magnet and its supports are outlined. Details of the manufacturing processes and the final assembly are included. A.

537.534 : 538.08 : 621.318.3 : 621.384.612

3559. Magnet. IV. Testing program for the individual blocks of the magnet. M. H. BLEWETT, J. M. KELLY AND W. H. MOORE. *Rev. sci. Instrum.*, **24**, 760–4 (*Sept.*, 1953).

The 288 blocks that constitute the Cosmotron magnet were tested, individually, to determine their magnetic characteristics. These measurements were used to arrange the blocks in an order that would minimize azimuthal harmonics. The remanent field

was the only magnetic parameter that showed appreciable deviations. A.

537.534 : 538.533 : 621.318.42 : 621.384.612

3560. Magnet. V. Coil. J. A. Kosh and M. S. Livingston. *Rev. sci. Instrum.*, **24**, 765–8 (*Sept.*, 1953).

The exciting winding of the Cosmotron magnet contains 48 turns that carry a peak current of 7000 A. The design, particularly of the special construction required at the ends of the magnet quadrants, is described. The sequence of processes is enumerated for the fabrication and assembly. After preliminary shakedown, periodic tests have shown no leaks to date. A.

537.534 : 538.1 : 621.311.6 : 621.384.612

3561. Magnet. VI. Power supply. G. K. Green and E. E. Shelton. *Rev. sci. Instrum.*, **24**, 769–72 (*Sept.*, 1953).

The power for the Cosmotron magnet is supplied by a 1750 h.p. 13 800 V induction motor that drives a 21 000 kVA 12-phase a.c. generator and a 43 ton flywheel, rotating at approximately 900 r.p.m. The generator output is rectified through 24 double-grid ignitrons which also act as inverters returning most of the magnetic energy of the coil to the rotating set. A.

537.534 : 538.533 : 621.318.3.045 : 621.384.612

3562. Pole-face windings. I. Design. J. P. Blewett, M. H. Blewett, W. H. Moore and L. W. Smith. *Rev. sci. Instrum.*, **24**, 773–6 (*Sept.*, 1953).

At fields over 10 000 gauss the effects of saturation in the Cosmotron magnet cause deterioration of the field pattern which rapidly becomes serious enough to cause complete loss of the proton beam. This pattern can be restored adequately up to 14 000 gauss by passing current through single-layer windings on the faces of the magnet poles. Peak correction current required at 14 000 gauss is about 300 A per radial inch of each winding. The pole-face winding returns are so arranged that the winding is almost completely decoupled from the main magnetizing winding. The windings and their power supplies are in place but are not yet energized. Several turns of the winding are used in a self-powered correction for the distortion of the magnetic median surface at injection fields. A.

537.534 : 538.533 : 621.318.3.045 : 621.384.612

3563. Pole-face windings. II. Fabrication. J. J. Mede. *Rev. sci. Instrum.*, **24**, 777–8 (*Sept.*, 1953).

The pole-face windings, for correction of saturation effects in the Cosmotron magnet, were wrapped in Fiberglas tape and then cast in a polyester-resin laminate. The process of fabrication and the materials used for casting are described. A.

537.534 : 538.561 : 621.373.42 : 621.384.612

3564. Radio-frequency system. I. Design principles. J. P. Blewett. *Rev. sci. Instrum.*, **24**, 779–81 (*Sept.*, 1953).

The Cosmotron r.f. system must supply a 2000 V radio-frequency accelerating signal across an insulated gap in the vacuum chamber. During the one-second accelerating cycle the frequency must vary from about 370 kc/s to 4·2 Mc/s at a rate determined by rate of change of the field in the gap of the Cosmotr magnet. Frequency is swept in an oscillator wh resonant circuit includes a ferrite-loaded satura inductor. The impedance of the gap and its as ciated shield is maintained by ferrite loading. description is included of the sequence of control a switching operations in the r.f. system during complete Cosmotron cycle.

537.534 : 538.561 : 621.373.42 : 621.384.6

3565. Radio-frequency system. II. Frequency c trol. J. P. Blewett, E. J. Rogers and C. E. Swar *Rev. sci. Instrum.*, **24**, 782–8 (*Sept.*, 1953).

Frequency control in the Cosmotron is based o signal derived from a pick-up loop in the magnet g This signal is integrated electronically and is t distorted in a nonlinear network to yield a cont voltage for the saturable-core oscillator. Syst constants are chosen such that the oscillator frequen has, at all times, the value associated with the insta taneous Cosmotron magnetic field. Dynamic f quency is measured by counting cycles for one mi second at any desired time during the cycle. Te on the present system indicate that it is adequa but that several simplifications are possible.

537.534 : 538.561 : 621.373.42 : 621.384.6

3566. Radio-frequency system. III. Power amp fier. M. Plotkin and L. C. L. Yuan. *Rev. Instrum.*, **24**, 789–94 (*Sept.*, 1953).

The 2 V signal from the low-level swept oscilla in the Cosmotron frequency-control system is amp fied to 2000 V, for application at the accelerating ga by two units. The first, the intermediate-level syste includes the functions of gating and a.v.c. The secon the high-level unit, is a push-pull broad-band amplif capable of an output of 150 kW. The gap voltage maintained constant by an a.v.c. system operat from a detector directly across the accelerating ga Metering, protection and control techniques a described.

537.534 : 538.561 : 621.373.42 : 621.384.6

3567. Radio-frequency system. IV. Accelerati unit. J. P. Blewett, M. Plotkin and E. J. Roge *Rev. sci. Instrum.*, **24**, 795–800 (*Sept.*, 1953).

The Cosmotron accelerating gap and its associat shield are driven by a broad-band amplifier. T impedance level at the gap is raised to the point which it can be driven by conventional power tub by loading the surrounding shield with ferromagne material. Extensive tests on loading materials l to the choice of nickel-zinc ferrite. About 28 pounds of ferrite are required. Techniques a described for fabrication and assembly of the ferr structure, and for excitation of the gap by the pow amplifier.

537.534 : 538.221 : 621.374.32 : 621.318

3568. Radio-frequency system. V. Properties ferromagnetic ferrites. J. P. Blewett, M. H. Blewe and M. Plotkin. *Rev. sci. Instrum.*, **24**, 800 (*Sept.*, 1953).

Ferromagnetic ferrites are used in numerous app cations in the Cosmotron. For example, in t

celerating unit over a ton of ferrite is included. uring the design of the Cosmotron, much infor- nation was required about the various electrical and agnetic properties of ferrites. Since this informa- on was not available, a detailed programme of vestigation of ferrite properties has been carried out. esults are presented of dielectric properties and of agnetic properties as functions of frequency, d.c. nd a.c. field strengths, and temperature. A general iscussion is included of the behaviour of electro- agnetic waves in ferrite structures. A.

537.534 : 621.319.339 : 621.384.612

569. Injection system. I. Van de Graaff accele- ator. E. J. ROGERS AND C. M. TURNER. *Rev. sci. nstrum.*, **24,** 805–15 (*Sept.*, 1953).

Protons, for injection into the Cosmotron, are ccelerated to about 3·6 MeV in a horizontal, pres- urized Van de Graaff accelerator rated at 4 MeV, eak. A pulsed ion source is included in the high- oltage terminal and is pulsed by an external circuit nked to the ion source through a light beam and hotocell. Pulsed ion output includes about 1 mA f protons. The terminal voltage is stabilized to part in 2000 by a servo loop that includes a deflection agnet, split-plate collector and grid-controlled orona discharge. A.

537.534 : 537.534.3 : 621.384.612

570. Injection system. II. Injection optics. J. G. OTTINGHAM, W. H. MOORE, E. J. ROGERS AND C. M. URNER. *Rev. sci. Instrum.*, **24,** 816–20 (*Sept.*, 1953).

The injection optical system, through which the ·6 MeV proton beam from the Van de Graaff ccelerator enters the Cosmotron, consists primarily f a deflecting magnet and an electrostatic inflector n which the beam is deflected through angles of 5° and 30°, respectively. Viewing and detecting echanisms are available for studies of alignment nd ion optics. The ion-optical properties of the ystem have been studied in detail; parameters have een chosen which yield an injected beam, parallel n the horizontal plane and diverging within an angle f 0·003 radian in the vertical plane. A.

537.534 : 533.5

571. Vacuum system. I. Vacuum chamber. D. D. ACOBUS AND I. J. POLK. *Rev. sci. Instrum.*, **24,** 21–31 (*Sept.*, 1953).

Details are given of the design, fabrication and ssembly, of the Cosmotron's vacuum chamber. our quadrant-length units, each shaped to fit the magnet's curvature, are joined by expansion joints to tainless steel straight-section boxes that house pecial component equipment. In the quadrant ections, the inner and outer walls are 1 in. thick, olid, low-permeability stainless steel; to minimize ddy currents, the top and bottom parts consist of eparated, stainless steel bars. An airtight cover of Myvaseal rubber is stretched over the top and bottom f the complete quadrant section. Tests on other models are discussed; outgassing measurements on several materials are included. Gaskets in the system are Myvaseal, and measurements on its properties and techniques for its use are described. A.

537.534 : 533,5

3572. The vacuum system. II. Pumping system. D. A. KASSNER AND C. LASKY. *Rev. sci. Instrum.*, **24,** 832–5 (*Sept.*, 1953).

Twelve 20 in. oil diffusion pumps are spaced around the Cosmotron's magnet ring to evacuate the vacuum chamber. These pumps, backed by 8 in. booster pumps and mechanical forevacuum pumps, are connected to manifolds in the wall of the vacuum chamber through 16 in. valves and large rectangular transition boxes. A complete system of interlocks gives fully automatic control. Present minimum operating pressure in the Cosmotron's vacuum chamber is 5×10^{-6} mm Hg. A.

537.534 : 537.534.74

3573. Revision of gas scattering theory. E. D. COURANT. *Rev. sci. Instrum.*, **24,** 836–7 (*Sept.*, 1953).

Previous estimates of the loss of protons through gas scattering are revised to include effects of scattering through angles large enough for immediate particle loss. In multiple-scattering theory, overestimates of loss may occur through use of the Born approximation. Appropriate corrections are discussed. A.

537.534 : 621.316.7 : 621.384.612

3574. The control system. I. Central control and wiring. G. K. GREEN AND R. R. KASSNER. *Rev. sci. Instrum.*, **24,** 838–45 (*Sept.*, 1953).

Control circuits for the Cosmotron radiate from a central control room and master terminal box. Remote control, indication and protective monitoring of all components are provided on a central control console. Extensive interlocks are necessary to protect equipment. Programming circuits automatically control the sequence of events during the operating cycle. The central control system provides integration of the components of the accelerator into a working entity. A.

537.534 : 621.374.33 : 621.316.7 : 621.384.612

3575. Control system. II. Timing system. E. W. DEXTER. *Rev. sci. Instrum.*, **24,** 846–7 (*Sept.*, 1953).

A gated timing system starts at the initial transient of the Cosmotron magnet cycle. Time markers in intervals from 10 μsec to 1 sec are available on patch-panel outputs. In addition, outputs are available at single specific times during the accelerating cycle. A.

537.534 : 621.316.7 : 621.384.612

3576. The control system. III. Peaking strips. S. GIORDANO, G. K. GREEN AND E. J. ROGERS. *Rev. sci. Instrum.*, **24,** 848–50 (*Sept.*, 1953).

Precise markers, indicating predetermined magnetic field strengths, are produced by fine high-permeability wires in the stray field of the Cosmotron magnet. Control is obtained by regulation of the currents through bias solenoids that surround the wire peaking strips. A.

537.534 : 621.316.7 : 621.384.612

3577. The control system. IV. Pickup electrodes. C. E. SWARTZ. *Rev. sci. Instrum.*, **24,** 851–3 (*Sept.*, 1953).

The circulating proton beam of the Cosmotron is bunched azimuthally by the r.f. acceleration. The protons pass through insulated electrodes inside the

vacuum chamber, and the voltage induced on these plates is used to monitor the beam and to explore its characteristics. The pick-up electrodes' signal is well above noise level. It can be displayed on an oscilloscope and utilized in many operations and investigations on the beam. A.

537.534 : 621.384.612

3578. The Cosmotron building. L. D. STOUGHTON. *Rev. sci. Instrum.*, **24**, 854–5 (*Sept.*, 1953).

Three wings house the Cosmotron and its associated equipment, offices for personnel and design laboratories and shops. The facilities in this building, including the cooling-water systems are described. A.

537.534 : 538.34 : 621.3.014.4 : 621.384.612

3579. Eddy-current phenomena in the Cosmotron. M. H. BLEWETT. *Rev. sci. Instrum.*, **24**, 856–60 (*Sept.*, 1953).

In the Cosmotron magnet, eddy currents in the half-inch laminations cause no serious effects except for a small increase in n value at injection time. This increase needs no correction since it is compensated by the reversed slope of the remanent field. Analyses of eddy-current effects in other metallic components of the Cosmotron are included, for example, in the pole-face windings and in the stainless steel vacuum chamber. Serious shifts in the magnetic median surface result from eddy currents that arise when either inner or outer vertical wall of the vacuum chamber is misaligned. A.

537.534 : 621.384.612

3580. Studies of injection phenomena in the Cosmotron. M. H. BLEWETT, G. K. GREEN, R. R. KASSNER, W. H. MOORE, L. W. SMITH AND H. S. SNYDER. *Rev. sci. Instrum.*, **24**, 861–8 (*Sept.*, 1953).

An intensive study of the behaviour of the proton beam in the Cosmotron has been made for the period just after injection, before the application of any accelerating field. The actual orbits have been traced for small variations in energy and time of injection in order to obtain optimum injection conditions. These orbits have been used to make further refinements on the adjustments of some of the injection components. The time required for the unaccelerated beam to spiral to the inside wall of the vacuum chamber is used as a basis for the normal injection routine. A.

537.534 : 621.384.612

3581. Calculation of the protons' radial oscillations at injection. E. D. COURANT AND R. M. STERNHEIMER. *Rev. sci. Instrum.*, **24**, 868–9 (*Sept.*, 1953).

The radial paths of the first two revolutions after injection have been calculated for variations in injection timing, injection position and initial angular direction. Graphs of some typical cases are included. A.

537.534 : 621.384.611

3582. Characteristics of a proposed double-mode cyclotron. M. J. JAKOBSON AND F. H. SCHMIDT. *Phys. Rev.*, **93**, 303–5 (*Jan.* 15, 1954).

It is proposed to accelerate ions in a fixed-frequency cyclotron, either with the dee voltages 180° out-of-phase, or with the dee voltages in-phase. This possible if the angular extent of the dee electrodes made less than the customary 180°. Formulae ha been derived for the energy gain per turn of ions wi various charge-to-mass ratios as a function of t angle of the dees. The threshold dee voltage f acceleration to a given energy is somewhat larg than that for conventional two-dee cyclotrons. F appropriate dee angles it is shown that both proto and deuterons can be accelerated in the nonrelativist energy region at substantially the same magnetic fie and oscillator frequency. Suggested applications acceleration of ions heavier than α-particles a discussed.

537.534

3583. The use of condensers to improve the "illumina tion" of a mass-spectrograph slit. H. EWALD AN G. SAUERMANN. *Z. angew. Phys.*, **5**, *No.* 10, 387- (1953) *In German.*

Two crossed pairs of deflecting plates in front the slit ensure that the ion current through the sl is the maximum possible. Automatic compensation any fluctuation can be achieved. L. PINCHER

537.534.3 : 545.82

3584. Recent developments in mass spectrometr J. G. HUTTON. *Trans. Instrum. Meas. Conf.*, 195 22–34.

After an historical introduction to the subjec recent work on precision mass determinations usin a conventional double-focusing mass spectromete and time-of-flight methods is described. An accoun of recent applications of the mass spectrometer t the isotopic analysis of solids and the determinatio of the age of minerals is given. The methods used t apply the mass spectrometer to routine alloy analysi are described in detail. The survey describes th applications of the mass spectrometer to petroleu analysis, where the method has been extended up t hydrocarbons with $m/e = 600$. A detailed accoun of the use of a mass spectrometer in the proces control of a catalytic cracking plant at the Ess Laboratories is given. Work on the ion resonanc mass spectrometer (Omegatron) is described and detailed account of attempts to use it for hydrocarbo analysis in the General Electric Laboratory was given D. R. CHIC

537.534.7

3585. Phase-shift analysis of high-energy p-p scatte ing experiments. A. GARREN. Letter in *Phys. Rev* **92**, 213 (*Oct.* 1); Erratum, 1587 (*Dec.* 15, 1953).

Assuming s and p waves only, the phase shift necessary to fit the observed isotropic differentia cross-section, and the left-right asymmetry in th angular distribution after two successive scattering were calculated. It was found that a fit could b obtained with a number of different combinations c phase shifts, and a table is given of some particula values. J. HUGHE

537.534.7

3586. Angular distributions of 22-MeV proton elastically scattered by various elements. B. L. COHE AND R. V. NEIDIGH. *Phys. Rev.*, **93**, 282–7 (*Jan.* 1 1954).

Angular distributions of 22 MeV protons elasticall

scattered by fifteen elements from beryllium to thorium were measured with the internal, circulating beam of the Oak Ridge National Laboratory 86-inch cyclotron. The experimental methods, which are somewhat unconventional, are described. The results show all the characteristics of diffraction scattering including at least two maxima and minima for each element. The angles at which these occur can be traced from element to element through the periodic table, following a λ/R dependence with fairly good accuracy. A.

537.534.74

3587. The elastic scattering of protons by alpha particles. S. Sack, L. C. Biedenharn and G. Breit. *Phys. Rev.*, **93**, 321–5 (*Jan.* 15, 1954).

The $p_{\frac{1}{2}}$ and $p_{\frac{3}{2}}$ phase shifts determined from analysis of the elastic scattering of protons by α-particles are treated in terms of a potential interaction between the proton and α-particle core, with a spin-orbit interaction of the Thomas type. The results are sensitive to the well shape chosen and favour a Gauss well interaction. The limitations of this type of treatment are discussed. A.

537.534.75 : 778.34

Ionization loss at relativistic velocities in nuclear emulsion. *See Abstr.* 3003

537.534.8

3588. Secondary emission during bombardment of a metal target by multiply charged ions. Yu. A. Dunaev and I. P. Flaks. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 1, 43–5 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-72.*

Measurements of secondary emission from pure Ni bombarded by singly and multiply charged Na, Ca and Ba ions and from Sb, Bi and Te bombarded by ions of these elements with energies up to 30 keV show that γ increases linearly with the energy of the incident singly-charged ions of all elements. Considerably enhanced yields were obtained with Na^{2+}, Ca^{2+}, Ba^{3+}, Ba^{4+}, Sb^{5+}, Bc^{4+} and Te^{5+}. The other ions of these elements gave the same γ as singly-charged ions. C. G. MORGAN

DISCHARGE TUBES . COUNTERS 537.54

537.542

3589. Secondary processes in the ion sources of mass spectrometers. V. L. Tal'roze and A. K. Lyubimova. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 5, 909–12 (1952) *In Russian.*

Presents results of investigations on ion sources with the following ionized media: saturated (CH_4, C_2H_6, C_3H_8, C_4H_{10}) and unsaturated (C_2H_4, C_3H_6, iso-C_4H_8) hydrocarbons, and H_2O. It has been found that the increase of pressure of the medium often causes the appearance of ions formed from the respective molecules by addition of a proton; thus H_3O^+, $C_3H_7^+$, $C_4H_9^+$ and CH_5^+ have been detected. Ethylene and saturated hydrocarbons other than CH_4 do not produce ions. Graphs enclosed show (1) the relationships between the pressure and the ratio η of the line intensity of the "proton-loaded" ions to that of the lines of the corresponding primary ions (for H_2O, C_3H_8 and CH_4), (2) the dependence of the ion current of CH_4^+ and CH_5^+ on the energy of the ionizing electrons, and (3) the dependence of the ratio η for CH_4 on the energy of the electrons, with and without the application of the magnetic field. Various deductions regarding the reaction mechanisms involved are made. F. LACHMAN

537.542

3590. A multiple shielding counter. J. Jóźwiak and W. Mościcki. Letter in *Acta phys. Polon.*, **11**, *No.* 2, 201–2 (1952).

Briefly describes a form of counter, suitable for anti-coincidence work, in which anode and cathode electrode wires are mounted in the space between two coaxial cyclinders (dia. 4·55 and 7·5 cm). J. D. CRAGGS

537.542

3591. The temperature dependence of spurious pulses in G–M counters. R. Seidl and F. Roubínek. *Czech. J. Phys.*, **1**, *No.* 3–4, 207–10 (1952).

The spurious counting rates are plotted against temps. (up to about 95°c) and the dependence is thereby established. Self-quenching mixtures with Pt cathodes were used. The effect is attributed to electrons or negative ions liberated at the cathode by exothermic reactions between incident and adsorbed molecules. J. D. CRAGGS

537.542

3592. Increasing range of Geiger tubes by pulsed operation. *Electronics*, **26**, 206, 208, 211–12 (*Oct.*, 1953).

A brief description of two methods which enable high effective counting rates to be used, i.e. high radiation intensities to be measured. These methods involve (*a*) the use of a quenching pulse applied to the counter and (*b*) a gating pulse, the duration of which is made the sensitive time. J. D. CRAGGS

537.542 : 537.583

3593. Effect of thermionic emission at room temperature in photosensitive Geiger–Müller tubes. K. Grotowski, A. Z. Hrynkiewicz and H. Niewodniczarski. *Bull. Acad. Polon. Sci. Cl.* 3, **2**, *No.* 3–4, 109–11 (1953).

Reports a study of the increase in background level with temperature which is often observed as an ageing effect with G–M counters. New, clean tubes did not show any dependence of background on T. However, when the counters were made photosensitive by running a discharge in argon, these tubes exhibited a strong increase in background count with T. The difference in count between the two runs was assumed to give a measure of the thermionic emission. The data thus obtained were used for a Richardson plot which proved to be a straight line with work function $\simeq 1{\cdot}0$ eV. The thermionic origin of the background count is thus confirmed. A. H. W. BECK

537.542

3594. A type of Geiger–Müller counter suitable for the measurement of high energy gamma-rays. M. Sonoda. *Mem. Coll. Sci. Univ. Kyoto A*, **25**, 175–83 (*Dec.*, 1949).

The construction is described of a brass counter for

low-energy γ's and a lead counter for high-energy γ's. Results obtained with the latter, and efficiencies with an argon-alcohol filling are given. 38 refs. F. R. HOLT

537.542

3595. On the proportional counter. M. SONODA. *Mem. Coll. Sci. Univ. Kyoto A*, **25**, 185–92 (*Dec.*, 1949).

The construction of, and curves obtained with, α and β proportional counters are given. F. R. HOLT

537.542

3596. Pulse-distribution evaluation of alpha-counting instruments. D. G. MILLER AND M. B. LEBOEUF. *Nucleonics*, **11**, 56–60 (*Nov.*, 1953).

The pulse amplitude distributions obtained with an α-particle source by means of a gridded ionization chamber and various types of proportional counters are described. The gridded chamber had the best characteristics in this respect, but, owing to long electron collection times ($\sim$20 μsec), gave large coincidence losses at high counting rates. The dependence of counting rate on source position and the effect of electrode diameter on the plateau length in the proportional counters, are discussed.

L. R. SHEPHERD

537.542

3597. Liquid scintillation counting of natural C^{14}. F. N. HAYES, D. L. WILLIAMS AND B. ROGERS. Letter in *Phys. Rev.*, **92**, 512 (*Oct.* 15, 1953).

537.542

3598. Preparation and performance of efficient plastic scintillators. W. L. BUCK AND R. K. SWANK. *Nucleonics*, **11**, 48–52 (*Nov.*, 1953).

The preparation of plastic phosphors by the polymerization of styrene or vinyltoluene containing various organic scintillators in solution, is described. The polymerization is carried out under vacuum to eliminate dissolved air and so preclude oxidation. The characteristics of the plastic scintillators prepared in this way, are discussed. Pulse heights and decay times comparable to *p*-terphenyl in xylene or stilbene crystals are obtained. L. R. SHEPHERD

537.542

3599. A scintillation spectrometer adapted for coincidence studies. M. LANGEVIN, G. ALLARD AND G. CORBÉ. *J. Phys. Radium*, **14**, 691–4 (*Dec.*, 1953) *In French.*

537.542 : 539.166.08

3600. Gamma-ray dosimetry with organic scintillators. R. T. CARR AND G. J. HINE. *Nucleonics*, **11**, 53–5, 68 (*Nov.*, 1953).

The ratio of energy absorbed in anthracene to that in air is computed theoretically, over a wide energy range, for thin and thick crystals. Experimental results in good agreement with theory, were obtained. It was found that organic scintillators display good air equivalence over the range 0·2 to 3·0 MeV, provided that the crystals are thin and covered with a suitable air-equivalent material to ensure secondary-electron equilibrium. NaI crystals were found to be air-equivalent over a more limited range between 0·6 and 2·0 MeV. L. R. SHEPHERD

537.54

3601. Counting slow electrons with an electron multiplier. J. A. COWAN. *Canad. J. Phys.*, **32**, 101–9 (*Feb.*, 1954).

The efficiency of counting slow velocity electrons by a 12-stage activated beryllium-copper electron multiplier was investigated. The total electron current in the incident beam was measured using an electrometer tube circuit. The number of pulses produced in the multiplier by the whole beam was counted using high-speed scaling circuits. The efficiency of counting was thus determined without depending on calibrated slits to divide the beam. Efficiency curves for primary energies between 200 and 900 eV are shown for freshly activated surfaces and also for surfaces which had been exposed to still air for five months. The curves were similar in shape, the former being a few per cent above the latter. A maximum of 63% was obtained for 300 eV input energies. A.

537.542

3602. On the theory of the spark counter. F. BELLA AND C. FRANZINETTI. Letter in *Nuovo Cimento*, **10**, 1335–7 (*Sept.*, 1953).

The authors suggest that the behaviour of spark counters (parallel plate electrodes) is consistent with the streamer theory of spark breakdown in a gas. In view of necessary assumptions they state that this does not constitute a proof of the theory which is developed in some detail in the paper. J. D. CRAGGS

537.542

3603. On spark counters. F. BELLA, C. FRANZINETTI AND D. W. LEE. Letter in *Nuovo Cimento*, **10**, 1338–40 (*Sept.*, 1953).

Describes a form of construction of parallel plate spark counters (2 mm gap). A time resolution of 10^{-9} sec was obtained; other characteristics are discussed and a plateau characteristic is given.

J. D. CRAGGS

537.542 : 621.387.4

3604. A linear spark counter for heavily ionizing particles. R. V. GÅSSTRÖM. *Trans Instrum. Meas. Conf.*, **1952**, 118–19.

Describes the electrode arrangement of a wire-plane Rosenblum counter, and the circuit required to give registration. The counter is selective and responds to α- but not to β- and γ-particles. J. D. CRAGGS

537.542

3605. Differential oscillographic discriminator and its application in coincidence circuits. F. DEMICHELIS AND R. MALVANO. *Nuovo Cimento*, **11**, 49–52 (*Jan.*, 1954) *In Italian.*

The differential discriminator described displays the pulses on the screen of a c.r.o., so that they can be photographed and be examined with a micro-photometer. A.

537.542 : 621.374.32

3606. A stable high speed multichannel pulse analyzer. E. GATTI. *Nuovo Cimento*, **11**, 153–62 (*Feb.*, 1954).

A 20-channel pulse analyser with a resolving power of 3 μsec is described. Its chief feature is that pulse

selection is accomplished by a single discriminator for each channel whose threshold is set at a height corresponding to the upper boundary of the channel and the channel width is determinated by suitably shaping the incoming pulses. A.

537.542

3607. A construction of a high pressure cloud chamber. S. MIYAKE, K. SUGA AND O. KUSUMOTO. *J. Inst. Polytech. Osaka City Univ. B*, **2**, 27–39 (*Oct.*, 1951).

The constructional details of a counter-controlled cloud chamber to work at 100 atmospheres are described. Results of preliminary work at 2740 m elevation are given and photographs of some uncommon events are included. J. HUGHES

537.542

3608. A diffusion cloud chamber with magnetic field for nuclear physics. A. LOVATI AND C. SUCCI. *Nuovo Cimento*, **11**, 163–71 (*Feb.*, 1954) *In Italian.*

The cloud chamber and its auxiliary equipment is described. The bottom of this chamber is cooled by an industrial refrigerator. Observations on the performance under different operating conditions are reported. A.

537.542

3609. Optimum and limiting operating conditions for downward diffusion cloud chambers. A. R. BEVAN. *J. sci. Instrum.*, **31**, 45–9 (*Feb.*, 1954).

Measurements on a diffusion cloud chamber operating with fillings up to pressures of 11 atm are interpreted according to a theoretical treatment by Shutt [Abstr. 356 (1952)]. The results can be used to determine temperature conditions required for good operation with any permanent gas at all useful pressures and for any given mean radiation intensity. Factors which interfere with normal operating conditions are considered. A.

537.543

3610. Approximate expression of the "3/2 law" for a finite cathode in a uniform field. I. I. LEVINTOV. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 6, 1247–50 (1952) *In Russian.*

Derives an approximate expression for the current density on the axis of the beam j_r for a current limited by a space charge, from a cathode with a radius r, possessing an infinitive emittive ability and placed in the uniform field of an anode V_a at a distance d from it. F. LACHMAN

IONIZATION . THERMIONICS 537.56/.58

537.56 : 539.18

3611. Ionization loss of relativistic particles in a gas. V. KHARITONOV. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 2, 285–7 (1952) *In Russian.*

The ionization of hard particles of energy 3×10^8 to $7\cdot2\times10^9$ eV is measured as a function of momentum. The momenta are measured by a magnetic system [Abstr. 2803 (1952)], and the ionization, by a proportional counter. At the high-energy end, the results agree with the lower values predicted by the Fermi–Wick theory, which takes into account the polarization of the medium, rather than with the Bethe–Bloch formula, although the measurement at $7\cdot2\times10^9$ eV falls slightly below even the Fermi-Wick value. G. E. BROWN

537.561 : 535.338

3612. The direct production of molecular electron spectra using the mass spectrometer. J. D. MORRISON. Letter in *J. chem. Phys.*, **21**, 2090–1 (*Nov.*, 1953).

By modulating the ionizing beam energy V in the mass spectrometer with a small amplitude signal at frequency f, the ion current I was modulated by an amount proportional to dI/dV at energy V. A phase-sensitive detecting circuit tuned to frequency f was made to record the magnitude of dI/dV independently of the value of I. A similar detector tuned to $2f$ was made to record a signal proportional to d^2I/dV^2. By further modulating V with a staircase waveform of 60 steps repeated each 20 sec, the first and second derivatives were plotted for the process $Hg \rightarrow Hg^+ + e$ over the range of V from 8–12 eV. D. R. CHICK

537.562

3613. The effective cross-section of very slow ions. B. ZIEGLER. *Z. Phys.*, **136**, *No.* 1, 108–18 (1953) *In German.*

Describes measurements of the scattering of very slow positive ions of Ne, A and Xe diffusing out of an ionization space. The scattering is measured, essentially, in a collimator. Energies of 0·8–1·2 eV are used. For A^+, at this order of energy, the cross-section is about $5\cdot5\times10^{-15}$ cm^2. Energies are measured with a time-of-flight arrangement. J. D. CRAGGS

537.563

3614. Negative ions of As, P, S, and Tl. V. M. DUKEL'SKIĬ AND E. YA. ZANDBERG. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 2, 263–5 (1952) *In Russian.*

See also Abstr. 7356 (1952). The following ions have been detected with the aid of a mass spectrometer: (1) As^-, As_2^- and As_3^- (probably produced all by the decomposition of the unstable As_4^-); when Sb containing 1% of As was introduced into the gas-discharge source, a line corresponding to ions $SbAs^+$ and $SbAs^-$ was observed; (2) P^-, P_2^- and P_3^-; (3) no negative N ions could be detected with certainty; (4) S^-, S_2^-, S_3^-, S_4^-, S_5^-, S_6^-, S_7^- and S_8^-; (5) Tl^- has been detected in the discharge of TlCl, TlBr and TlI along with TlX^-, TlX_2^-, X^- and X_2^-. F. LACHMAN

537.564

3615. Slow inelastic collisions between atomic systems. D. R. BATES AND H. S. W. MASSEY. *Phil. Mag.*, **45**, 111–22 (*Feb.*, 1954).

The physical mechanisms of the various processes which may occur as a result of encounters between low-velocity atoms or ions are discussed, particular attention being paid to the factors which determine whether or not a collision is likely to be near-adiabatic.

The following are the processes considered: excitation, $A + B \rightarrow A + B'$, $A^+ + B \rightarrow A^+ + B'$, $A^+ + B \rightarrow A^{+\prime} + B$; charge transfer, $A^+ + B \rightarrow A + B^+$, $A^- + B \rightarrow A + B^-$, $A + B \rightarrow A^+ + B^-$, $A^{++} + B \rightarrow A^+ + B^+$; ionization, $A + B \rightarrow A + B^+ + e$, $A^+ + B \rightarrow A^+ + B^+ + e$, $A^+ + B \rightarrow A^{++} + B + e$; detachment, $A^- + B \rightarrow A + B + e$, $A^- + B \rightarrow AB + e$. A.

537.564 : 537.52

3616. Ionization processes in the electrical breakdown of gases. F. Llewellyn Jones. *Brit. J. appl. Phys.*, **5**, 49–53 (*Feb.*, 1954).

In elucidating the phenomena of breakdown it is necessary first to find the general mechanism by which the various processes of ionization interact to produce the necessary amplification of current, and then to identify the particular ionization processes themselves. It was the exact prediction, both of the form of the growth of ionization and of the breakdown potentials, when the spark parameter *pd* was less than about 200 (mm Hg × cm), that first established the validity of the Townsend theory based on the continuous development of ionization by primary and secondary ionization processes; the main characteristics of this theory are given. The problem of breakdown at higher pressures when *pd* is $\simeq 760$ (mm Hg × cm) is next discussed, and recent experimental and theoretical work on the growth of ionization currents and breakdown is described, from which it is concluded that the general Townsend mechanism can also account for breakdown in this range of the spark parameter. This mechanism is then discussed in relation to other properties of breakdown involving the spatial-temporal development of currents, breakdown under impulse voltages, under non-uniform fields and, finally, in highly compressed gases at very high voltages. A.

537.564 : 539.164.92

3617. The ionization in air maintained by a uniform plane circular distribution of α radioactivity. R. W. Nicholls. *Amer. J. Phys.*, **22**, 59–61 (*Feb.*, 1954).

The rate of ionization maintained in air in the region of a uniform plane circular distribution of α-radioactivity has been computed numerically and is shown graphically. Such information is of interest as a lower limit upon the excitation rate maintained by the same source and is of use in the interpretation of spectroscopic observations in the excitation of radiation caused by the passage of positive ions (α-particles in this case) through gases. A.

537.568

3618. Metastable negative ions. B. L. Donally and H. E. Carr. *Phys. Rev.*, **93**, 111–14 (*Jan.* 1, 1954).

Metastable negative ions have been detected with a mass spectrometer during an electron bombardment study of ethyl dichlorophosphate. Seven transitions for these metastable negative ions are tabulated, and the half-lives of two of these ions have been measured using a method proposed by Hipple. Measurements on the metastable ions in the transitions $C_2H_5PO_2Cl_2^- \rightarrow PO_2Cl^- + [C_2H_5Cl]$ and $PO_2Cl^- \rightarrow Cl^- + [PO_2]$ give $1{\cdot}9 \times 10^{-6}$ and $4{\cdot}8 \times 10^{-6}$ sec, respectively, as their half-lives. A.

537.568

3619. Electron capture by slow singly charged helium ions in helium. J. D. Jackson. *Canad. J. Phys.*, **32**, 60–4 (*Jan.*, 1954).

The capture of electrons by slow singly-charged helium ions passing through helium gas is discussed theoretically. Calculations of the capture cross-section for incident ion energies from 200 eV to 100 keV are made using an impact parameter method due to Kohn. In this energy interval the computed cross-section is found to be fitted very closely by the empirical expression $(\sigma/\pi a_0^2) = 7{\cdot}94 - 2{\cdot}35 \log_{10} E$ (keV). The results are compared with recent experimental data. The agreement between theory and experiment is good, except for the data of Keene. A.

537.568

3620. The detachment of electrons from negative ions. J. B. Hasted. *Proc. Roy. Soc. A*, **222**, 74–83 (*Feb.* 23, 1954).

Detachment cross-sections for collisions of O^-, Cl^-, F^- ions with rare-gas atoms are measured between 50 and 4000 eV incident-ion energy. The negative ions are produced (i) by thermal dissociation of molecules at a filament, followed by radiative attachment into the ground state; (ii) by electron bombardment of molecules, giving ions previously believed to be in an excited state of long lifetime. In every case the detachment cross-sections for the ions produced in the two ways are the same, so that we must conclude either (i) that the excited state has a short lifetime which is unlikely but not impossible, or (ii) that no excited state exists, and that the appearance potentials for ions believed to be in this state must be explained by another process, such as the formation of O neutrals followed by radiative attachment at the source filament. A.

537.568 : 551.510.535

3621. Recombination in the *F*-layers. A. L. Stewart. Letter in *Nature* [*London*] **173**, 165 (*Jan.* 23, 1954).

Assuming that the operative process is dissociative recombination with a molecule XY^+, Banerji [Abstr. 2949 (1954)] has suggested that the latter may be formed by charge transfer to metastable nitrogen $N_2'(A)$ from O^+. It is shown that the concentration of $N_2'(A)$ required is very much greater than that produced by solar excitation of $N_2(X)$. G. M. Brown

537.583

3622. Periodic deviations in the Schottky effect. S. C. Miller, Jr and R. H. Good, Jr. *Phys. Rev.*, **92**, 1367–72 (*Dec.* 15, 1953).

The periodic deviations in the Schottky effect are recalculated. The same basic model is taken as in the work of Guth and Mullin (1941), and of Juenker, Colladay and Coomes [Abstr. 6120 (1953)]. The difference between this work and the previous treatments is that WKB-type approximations are used. It is felt that these remove some of the uncertainties in the derivation. The results are essentially the same as those of Juenker, Colladay and Coomes, except that the amplitude of the deviations found is about twice as large and has a slightly different dependence on the field. A.

COSMIC RAYS 537.591

537.591.1

3623. Photographic plate measurements of the cosmic radiation on the occasion of the Swiss Himalayan expedition of 1952. A. EUGSTER AND K. HINTERMANN. *Experientia*, **9**, *No.* 8, 287 (1953) *In German.*

On the occasion of the 1952 Swiss Himalayan expedition nuclear emulsion plates were taken to a height of 8000 m in order to measure the intensity of the nucleonic component of the cosmic rays. The observed number of stars agrees with the results of other workers. H. ELLIOT

537.591.1

3624. On the spectrum of the photon component at sea level. C. CERNIGOI AND G. POIANI. *Nuovo Cimento*, **11**, 41–8 (*Jan.*, 1954) *In Italian.*

The shape of the photon spectrum of cosmic rays at sea level is obtained measuring the absorption of the photon materialization products in an anti-coincidence device and putting these data in comparison with those observed using the shower theory under Rossi's "B" approximation. A good agreement is found by taking a power spectrum with exponent 2·1. As the experimental device is particularly sensitive to low and medium energies, it can be inferred that this value is in agreement with modern views of the electrophotonic component in the air, but in the meanwhile it is suggested that the spectrum exponent could not be the same in the whole energy range, but rather variable as a function of the energy. A.

537.591.1

3625. Energetic nuclear collisions in the upper atmosphere. I. The nucleon pion cascade. U. HABER-SCHAIM AND G. YEKUTIELI. *Nuovo Cimento*, **11**, 172–87 (*Feb.*, 1954).

This is treated by an extension of the Fermi theory of pion production. The cascade equations are solved by an expansion in powers of the atmospheric depth. The contribution of primary α-particles is considered in detail. The results are applied to the calculation of the attenuation mean free path of the nucleonic component and the ratio of neutral to charged nuclear particles. A.

537.591.15

3626. On the electrons and photons in extensive cosmic ray air showers. C. MILONE. *Nuovo Cimento*, **10**, 1126–41 (*Aug.*, 1953) *In Italian.*

The showers were selected by the discharge of three out of four counters placed at the corners of a 5 m square and situated 40 m above sea level. The ratio of numbers of photons to electrons was determined at the centre of the selecting array and at a distance of 50 m. This ratio was approximately unity in each case. The absorption coefficients for the photons was also measured at the two points and it is concluded that a high percentage of the photons have an energy less than 10 MeV. H. ELLIOT

537.591.15

3627. On the narrow air shower. S. HIGASHI AND T. KUBOZOE. *J. Inst. Polytech. Osaka City Univ. B*, **2**, 41–3 (*Oct.*, 1951).

Describes an investigation of narrow showers using hodoscoped counters. It is concluded that the showers were very likely produced by μ-meson knock-on electrons. H. ELLIOT

537.591.15

3628. An investigation on jets. C. CASTAGNOLI, G. CORTINI, C. FRANZINETTI, A. MANFREDINI AND D. MORENO. *Nuovo Cimento*, **10**, 1539–58 (*Nov.*, 1953).

The authors present a statistical method for the determination of the energy of the primary of a nucleon-nucleon collision in which secondary particles are produced. Such a method, which represents an appreciable improvement with respect to the procedures used by other authors, makes use of all the information that can be obtained from the measurements of the angles of the shower particles of a jet. The statistical error on the energy of the primary is given by a very simple formula and turns out to be always very large and increases with the anisotropy of the emitted particles in the centre of gravity frame of reference. The method, which can be applied by successive approximations, is used to discuss 43 jets due to p (28), n (6) and α (9) primaries. Besides the energy per nucleon of the primary of each jet, some information on the angular distribution of the emitted particles in the centre of gravity system, is deduced. The first approximation is based on the assumption that all the emitted particles have, in the centre of gravity frame of reference, the same velocity as the two colliding nucleons before the collision. A critical discussion of the determination of the energy of the primary shows that the result of this approximation has not in general much significance. The solution of second approximation needs the knowledge of the spectrum of the emitted particles and depends rather strongly on such a spectrum: if the experimental spectrum is reasonably well represented by a formula of the same type as that of Fermi's thermodynamical theory, the determination of the energy will be fairly satisfactory only if it is at least 50 000 MeV. But if the experimental spectrum can be represented for energies of the emitted particles much larger than $m_\pi c^2$, by a formula of the same type as that of Heisenberg, the evaluation of the energy of the primary will depend very strongly on the behaviour of the adopted spectrum at low energy also for ultrarelativistic collisions. A.

537.591.15

3629. Note on hard showers. P. VAN DER LEEDEN. *Physica*, **19**, 1145–57 (*Dec.*, 1953).

The distinction between extensive and narrow showers seems to be non-essential. It reduces in essence to the generation of showers far away and nearby. Both types seem to be produced by the same process, i.e. catastrophic collisions and the apparent difference is merely introduced by the particulars of the experimental coincidence technique of shower registration. It is to be expected that even this apparent difference will not be found above a height of about 4 km. For the determination of a, the variation of showers generated nearby and the study of bursts seem to be the most promising methods. In all determinations of a published thus far the decrease of effective aperture of the primaries with increasing atmospheric depth has been neglected. Thus a might well become 10% too high. The variation of hard showers generated far away, the so-called

extensive ones, does not seem suitable for the determination of a. A.

537.591.15

3630. Atmospheric temperature effect for μ mesons observed at a depth of 846 m.w.e. N. SHERMAN. *Phys. Rev.*, **93**, 208–11 (*Jan.* 1, 1954).

The experiment reported was a measurement of the effect of variations in atmospheric temperatures on the intensity of μ-mesons observed underground at a depth of 846 m.w.e. The average energy of these particles is known to be $\sim 2 \times 10^{11}$ eV. A total of $\sim 1{\cdot}2 \times 10^6$ coincidences, between two large trays of Geiger counters located in a salt mine, was collected over a two-year period. The correlation between variations in counting rate and simultaneous variations in effective atmospheric temperature was analysed. The effective temperature was determined from radiosonde measurements of atmospheric temperatures at pressure levels up to 20 millibars performed by a U.S. Air Force weather observation unit near the salt mine. The resulting temperature coefficient is $0{\cdot}22 \times 0{\cdot}06\%$ per degree and the correlation coefficient is 0·75. The results are compared with those obtained from similar measurements at 1574 m.w.e. and with the theoretical values of the temperature coefficient derived from various schemes describing the production of μ-mesons with high energies. A.

537.591.15 : 537.533.9

3631. Three dimensional theory of electron-photon showers. B. A. CHARTRES AND H. MESSEL. *Proc. Phys. Soc.* [*London*] *A*, **67**, 158–66 (*Feb.*, 1954).

The method developed by Messel and Green [Abstr. 1443 (1954)] of solving the diffusion equation of the general mixed cascade for the moments of the distribution functions is applied to an electron-photon cascade initiated by a single electron or photon when provision is made for loss of electron energy by ionization. Exact solutions for the Mellin transform of the $2n$th angular and $2n$th radial moments are given. It is shown that the $2n$th radial moment increases asymptotically as n^{4n} and that the radial distribution function is of the form $\exp(-ar^{1/2})$ for all but the core of the shower. Numerical results are given for the lower moments and compared with previous results. A.

537.591.3

3632. Proton intensities at sea level and 9000 feet. A. Z. ROSEN. *Phys. Rev.*, **93**, 211–14 (*Jan.* 1, 1954). The vertical intensities of protons which occur singly in the cosmic radiation have been measured at 9000 ft and at sea level. The particles observed were those whose momenta, recorded by cloud chambers above and below a magnetic field, were between 0·59 and 0·93 BeV/c after having traversed various thicknesses from 0 to 345 g/cm^2 of lead absorber placed over the apparatus. The identification of the particles was achieved by a mass determination based on the measured momentum and the range observed in a third cloud chamber containing copper plates. With no absorber over the apparatus, the differential momentum intensity at 9000 ft was found to be $8{\cdot}9 \pm 0{\cdot}9 \times 10^{-4}$ (BeV/c)$^{-1}$ sec^{-1} sterad^{-1} cm^{-2}. In conjunction with the data obtained at sea level with the same apparatus, an effective absorption length of 136^{+13}_{-8} g/cm^2 of air was found for protons of the mean momentum 0·76 BeV/c. From this absorpti length and the evidence that production between t two levels of observation plays a predominant role value of 134 g/cm^2 for the absorption length of t primary particles was deduced.

537.591

3633. The zenithal distribution of the component the cosmic rays which produces narrow, soft, showe L. MITRANI. *Izv. Bulg. Akad. Nauk*, **2**, 99–106 (195 *In Bulgarian.*

An experimental investigation of the zenith distribution of the cosmic-ray component produci electron showers and of the displacement wi increasing mean energy of the shower-produci primary particles of the maximum of Rossi's curv as predicted by theory. Fourfold coincidence a counter-coincidence arrangements were used. complete measurement of the Rossi curve was ma for every zenithal angle with screens up to 4 cm P The curves show no sign of displacement of t maximum up to 60° zenith angle, this agreeing wi high-altitude measurements of various authors, b being contrary to theory and to measurements other authors. The curve of the zenith angle depe dence may be represented very well by the expressi $J = J_0 \cos^{2.5} \theta$ (for the shower-producing componen whereas the distribution of the total radiation better represented by the relation $J = J_0 \cos^2 \theta$. Th indicates a stronger absorption of the showe producing component, compared with the tot radiation, by the atmosphere. B. F. KRAU

537.591

3634. Delayed disintegration of a heavy fragme emitted in nuclear explosion. M. DANYSZ AND PNIEWSKI. *Bull. Acad. Polon. Sci. Cl.* 3, **1**, *No.* 1– 42–4 (1953).

Discusses two associated stars A and B observe in a G5 plate exposed at 85 000 ft. Star B appea to be produced by a heavy fragment emitted fro star A. The charge on the fragment is estimated t be ~12. Its final energy, deduced from the trac width at the end of its range, is much less than tha required to produce star B which has 4 prongs an corresponds to an energy release ⩾120 MeV. Possib interpretations are discussed and it is concluded tha this star represents the disintegration of the heav fragment after a time of flight of $\sim 10^{-11}$ sec. H. ELLIO

537.591

3635. Recoil tracks in nuclear disintegration sta produced by cosmic radiation. M. GRILLI AND E VITALE. *Nuovo Cimento*, **10**, 1047–78 (*Aug.*, 1953) *Italian.*

The range and angular distribution of recoil track has been investigated for three groups of stars wit primary energy in the ranges 0–300, 300–500 an 500–1000 MeV. The results are compared with statistical analysis using the Monte Carlo method an good agreement is obtained for the middle group.

H. ELLIO

537.591

3636. Further results on the interaction of cosmi rays underground. A. LOVATI, A. MURA, C. SUCC AND G. TAGLIAFERRI. Letter in *Nuovo Cimento* **10**, 1201–4 (*Aug.*, 1953).

The production of penetrating secondaries b

μ-mesons at a depth of 55 m.w.e. has been investigated using a multi-plate cloud chamber under 90 cm Al. It is concluded that the cross-section for production of penetrating secondaries is not appreciably greater than for nuclear disintegrations. Evidence is presented for the emission of a π^0-meson from a star produced in one of the lead plates in the chamber.

H. ELLIOT

537.591.8

3637. On the positive excess of mesons of high energy. E. BERETTA, I. FILOSOFO, B. SOMMACAL AND G. PUPPI. Letter in *Nuovo Cimento*, **10**, 1354–6 (*Sept.*, 1953).

The positive excess of μ-mesons has been measured underground for three energy bands round 3·2, 5·5 and $9{\cdot}5 \times 10^9$ eV. The values obtained were 23·4, 22·7 and 22·0% respectively. These results, which are in good agreement with those at sea level, are discussed in relation to the mean multiplicity of meson production.

H. ELLIOT

537.591.8

3638. On the possible existence of associated knock-on electrons. A. W. WOLFENDALE. Letter in *Nuovo Cimento*, **10**, 1493–4 (*Oct.*, 1953).

The probability of production of knock-on electrons has been investigated at sea level under 1 m lead and underground at a depth of 26 m.w.e. using a multiplate cloud chamber. The observed frequency of successive production in 2 or 3 plates agrees with that calculated on the assumption that the secondaries are produced independently.

H. ELLIOT

537.591.8

3639. On the existence of unstable charged particles of hyperprotonic mass. A. BONETTI, R. L. SETTI, M. PANETTI AND G. TOMASINI. *Nuovo Cimento*, **10**, 1736–43 (*Dec.*, 1953).

See Abstr. 577 (1954). Further evidence is presented in favour of the existence of charged unstable particles of hyperprotonic mass. In two cases the decay product is a fast light particle, in one case it is a slow proton. The decay schemes: $\Omega_\pi^\pm \rightarrow n + \pi^\pm + Q$; $\Omega_p^+ \rightarrow p + \pi^0 + Q$ are proposed for the two types of events respectively. They are possibly alternative modes of decay of the same type of H-particle. The evidence available from photographic emulsion and cloud chamber experiments is discussed.

A.

537.591.8

3640. High-energy meson production. N. M. DULLER AND W. D. WALKER. *Phys. Rev.*, **93**, 215–26 (*Jan.* 1, 1954).

The angular distributions of penetrating secondary particles from showers originating in lead and in carbon have been studied. Because the distributions for the two materials are very similar, it seemed meaningful to analyse them in terms of nucleon-nucleon collisions. From the kinetics of such collisions, it is possible to estimate the energy of the primary producing the interaction. If the angular distribution in the centre-of-mass system is uniform, then $[F(\theta)]/[1 - F(\theta)] = \gamma_c^2 \tan^2 \theta$, where $F(\theta)$ is the fraction of the shower particles emitted within an angle θ in the laboratory system and γ_c is the γ of the centre-of-mass motion. By making plots of $\log [F/(1 - F)]$ *v.* $\log \tan \theta$, the γ_c of the interaction is found. Also, it is established that the angular distribution of particles produced in 10–40 BeV interactions is uniform in the centre-of-mass system. The average number of mesons produced in showers of about 30 BeV primary energy is 3 to 4. From estimates of secondary momenta it appears that, on the average, the mesons are produced with about 500 MeV energy in the centre-of-mass system. Thus the collision of a 30 BeV nucleon with a target nucleon would seem to be, on the average, not 100% inelastic. A rough determination has been made of the mean free path for penetrating shower production *v.* energy for the secondary π-mesons. The cross-section for further meson production is found to be about 0·1 geometric in lead at 1 BeV rising to geometric for energies greater than 4 BeV. The secondaries produced in meson-nucleon collisions seem to be distributed uniformly in the centre-of-mass system. Arguments are presented to show that less than 15% of the secondaries of penetrating showers are heavy mesons.

A.

537.591.8 : 539.185

Diffraction effects in the scattering of neutrons, μ mesons and electrons by nuclei. *See Abstr.* 3892

MAGNETISM 538

538.082.743

3641. Experiments on the distortion of the field of a magnetic probe (developed by F. Förster) in the presence of a ferromagnetic body. F. BRANDSTAETTER. *Elektrotech. u. Maschinenbau* [*EuM*] **70**, 452–5 (*Oct.* 15, 1953) *In German.*

Describes investigations of the Förster probe previously described [Abstr. 2824 (1952)]. The magnetic field in the neighbourhood of the two Permalloy cored coils forming the double transformer of the instrument was measured with a small search coil with and without the presence of a thin iron strip. The effect of the strip was to increase the concentration of the field into two sharp maxima on either side of the coils.

E. P. WOHLFARTH

538.1/.2

3642. Work on magnetism in the U.S.S.R. S. ROSENBLUM. *Nuovo Cimento*, **10**, *Suppl. No.* 4, 441–58 (1953) *In French.*

A survey with bibliography (223 refs.) devoted almost entirely to ferromagnetism. The period covered is roughly 1936–1952.

538.1 : 537.534 : 621.318.3 : 621.384.612

The Cosmotron magnet. *See Abstr.* 3556–61

538.114

3643. Theory of antiferromagnetism. K. YOSIDA. *Annu. Rep. Sci. Works Fac. Sci. Osaka Univ.*, **1**, 19–38 (1952).

A theoretical discussion of the properties of antiferromagnetics in an external field large compared with the mean of the exchange and anistropy fields. In such fields the spin system changes its direction so as to lie perpendicular to the field direction. The

nature of the anisotropy is discussed and the main contributions to the anisotropy energy (arising from the crystalline field and magnetic dipole interactions) are calculated for MnF_2 and MnO_2. E. P. WOHLFARTH

538.114

3644. Quantum theory of a new origin of ferromagnetism. G. HEBER. *Ann. Phys.* [*Leipzig*] **13,** *No.* 1–5, 44–72 (1953) *In German.*

An extension of previous theoretical work by the author [Abstr. 1741 (1953)]. Zener's indirect exchange mechanism is discussed quantitatively and compared in its importance with the usual direct exchange mechanism. The *d* shells in ferromagnetic substances are treated on the basis of the band model [as previously discussed by Slater (1937)], but the change of magnetization with temperature is shown to obey a relation derivable from a phenomenological spin wave treatment; the relation $M/M_0 = 1 - a(kT/J)^{\frac{3}{2}}Z_{\frac{3}{2}}(J/kT)$ is derived for three-dimensional lattices. Here J is the direct exchange integral, I an integral giving a measure of indirect exchange and $Z_m(x) = \sum_{n=1}^{\infty} n^{-m}\exp(-nx) = O(e^{-x})$ for $x \to \infty (kT/I \to 0)$. A comparison with experimental results for the ferromagnetic metals (stated to show the validity of the $T^{\frac{3}{2}}$ law) indicates that the indirect exchange mechanism is only of secondary importance compared with the direct exchange mechanism ($I \ll J$), in contrast with Zener's conclusions. E. P. WOHLFARTH

538.114

3645. Theory of displacement of domain boundaries. N. S. AKULOV AND G. S. KRINCHIK. *Dokl. Akad. Nauk SSSR,* **89,** *No.* 5, 809–12 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-106.

The velocity of displacement of domain boundaries in ferromagnetic substances is shown to be given by the relation $v = A(H - H_0)$, where A and H_0 are constants and H is the applied field strength. The constant A is calculated on the basis of certain simplifying assumptions as to the damping effects of eddy currents in the substance. The formula is in good agreement with experiment. E. P. WOHLFARTH

538.114

3646. Transition factor in superexchange interaction matrix. T. OHTA. Letter in *Progr. theor. Phys.*, **9,** 85–6 (*Jan.*, 1953).

A method of computation of the transition factor in the Kramers theory of superexchange as formulated by Anderson [Abstr. 8114 (1950)] is described.

G. E. BROWN

538.114

3647. A theory of antiferromagnetism. T. OGUCHI AND Y. OBATA. *Progr. theor. Phys.*, **9,** 359–69 (*April*, 1953).

A theory of antiferromagnets based on Heisenberg model is developed by a method which is much more directly the analogue of the original Bethe method than Weiss-Li's. By the present method, the calculations can be carried out over all temperatures. Especially, the situation at lower temperatures which is obscure in Weiss-Li's papers is made clear. Thus it can be seen that an anti-Curie point which Anderson has proposed, does not occur, if the densit matrix of a cluster is calculated exactly without th perturbation method. By considering only a sma cluster, being characteristic of the Bethe approxima tion, the long wavelength spin waves, which ar important at lower temperatures, are excluded, s that the magnetization of the sublattice is completel saturated at 0°K in just the same way as in the Isin model. It is shown that, in the Bethe approximation the Curie point of an antiferromagnet is higher tha that of ferromagnet, for the same magnitude of $|J|$. A

538.11

3648. The Heisenberg theory of ferromagnetism o the crystal constituted by the atoms with spin one H. NAKANO. *Progr. theor. Phys.*, **9,** 403–13 (*April* 1953).

It is proved that the Hamiltonian of the crysta constituted by the atoms having spin s larger tha $\frac{1}{2}$ can be expressed by $-2J\Sigma s_i.s_j$ in terms of the spi vector s_i and s_j, of the nearest neighbouring atoms i the same way as in the case $s = \frac{1}{2}$, as far as th Hund rule prevails in each constituent atom in th molecular fields. The Curie points of a few lattic types are obtained in the stage of the first, the secon and third approximation. These are all higher tha those corresponding to the case $s = \frac{1}{2}$. Especiall in the second approximation the Curie point T_c is give by the formula $T_c = 11J/[3k\{1 - \sqrt{(1 - 11/2z)}\}]$ i terms of the exchange integral J between the neares neighbouring atoms, the co-ordination number z an the Boltzmann constant k. The condition for appear ing of ferromagnetism in this approximation is tha $z = 6$. A

538.11

3649. Magnetism and interatomic distance. F BADER. Note in *Z. Naturforsch.*, **8a,** 675–6 (*Oct.* 1953) *In German.*

A brief qualitative discussion purporting to explain the pressure dependence of the Curie temperature o ferromagnetic metals in relation to the dependence o the exchange integral on interatomic distance and t related questions. A quantitative result, that the exchange integral using the radial component o atomic 3*d* wave functions is negative, is reported [see Abstr. 1315 (1949) for an earlier calculation].

E. P. WOHLFARTH

538.114

3650. A modified form of Heisenberg's theory o ferromagnetism. R. H. TREDGOLD. *Proc. Phys. Soc* [*London*] *A*, **67,** 148–52 (*Feb.*, 1954).

The Heisenberg theory of ferromagnetism is extended to include exchange interactions between atoms other than nearest neighbours. The calculation is carried through as far as the third approximation and a general expression for the susceptibility above the Curie point is obtained. A particular law of variation of exchange interaction with distance is investigated and it is shown that the results obtained reproduce the general features of the susceptibility versus temperature curves of real ferromagnetic materials. A.

538.22 : 537.311.33

The magnetic properties of semiconductors with special consideration of grey tin. *See Abstr.* 3479

538.221/.222

3651. Relaxation effects in para- and ferromagnetic resonance. N. BLOEMBERGEN AND S. WANG. *Phys. Rev.*, **93**, 72–83 (*Jan.* 1, 1954).

Magnetic resonance experiments have been carried out at 3 cm wavelength in paramagnetic and ferromagnetic samples at very high microwave power levels, in a temperature range between 77°K and 700°K. Changes in the microwave susceptibility and the d.c. magnetization have been observed for microwave amplitudes between 1 and 50 Oe. For a paramagnetic salt, $MnSO_4.4H_2O$, these changes are readily interpreted in terms of a spin-lattice relaxation mechanism. The value for the spin-lattice relaxation time is derived in three different ways and agrees well with that obtained by Gorter's non-resonant method. When a large exchange interaction occurs between the spins, the situation above the Curie point can be described in terms of a conversion of magnetic into exchange energy. The magnetic and the spin-exchange systems are not always in thermal equilibrium. The characteristic time for the transfer of energy between these systems is equal to the inverse of the line width, which is given by the Van Vleck–Anderson formula for exchange narrowing. Experimental results for an organic free radical and some ferrites confirm this point of view. Below the Curie temperature the situation is more complicated. The experimental data for several ferrites and Supermalloy show qualitatively the same behaviour. The absorbed magnetic energy is again converted into exchange energy with a characteristic time which is always shorter than 3×10^{-8} sec. At high temperatures this time is equal to the inverse line width and the transition to the paramagnetic region is continuous. At low temperatures the relaxation time increases roughly inversely proportional to the temperature although the width remains constant. The microwave susceptibility has an anomalous decrease at high power levels. No satisfactory explanation has been found for these effects in existing theories. A.

538.221

3652. Effect of the division into elementary domains on the high frequency permeability of ferromagnetic conductors. L. NÉEL. *Ann. Inst. Fourier*, **3**, 301–19 (1951) *In French.*

In the treatment proposed it is assumed that near the surface of the substance the domains have the shape of parallel slabs perpendicular to the surface and that the domain boundaries may be distorted without loss of energy. A classical calculation gives the values of the real and imaginary components of the complex permeability as a function of a reduced frequency. The reduction factor involves, *inter alia*, the domain width, d. For small values of d the effect of the finite surface energy of the domain boundaries is investigated and found to be negligible if d is larger than a few μ. E. P. WOHLFARTH

538.221

3653. Ferromagnetic resonance in parallel wires as a function of extension. A. G. KOTOV. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 4, 531–3 (1952) *In Russian.*

For Ni increase of tension from 3·2 to 28 Kg/mm² increases the ferromagnetic resonance maximum at 9·1 cm from 440 to 700 oersted and increases its height. For Fe an increase from 10 to 40 Kg/mm² increases the field from 500 to 540 oersted and decreases the height by 20% at 3·2 cm. At a fixed field, 1300 oersted and wavelength, 3·2 cm, Ni shows a maximum in loss with respect to tension at 5 Kg/mm². D. H. WHIFFEN

538.221

3654. The definition of the ferromagnetic state having maximum stability. J. CREUSOT AND A. LANGEVIN. *C.R. Acad. Sci.* [*Paris*] **237**, 1499–500 (*Dec.* 9, 1953) *In French.*

Describes results of experiments on cylindrical specimens of soft iron and steel, cobalt steel and Fe–Ni. For each value of the field strength H (up to 500 oersted) a unique value of induction B is obtained by an application of an alternating field whose amplitude is reduced continuously to zero. The relation between B and H is given by the Langevin–Weiss formula. E. P. WOHLFARTH

538.221

3655. Ferromagnetic investigation of polycrystalline and monocrystalline cementite. P. BLUM AND R. PAUTHENET. *C.R. Acad. Sci.* [*Paris*] **237**, 1501–2 (*Dec.* 9, 1953) *In French.*

Describes measurements of the temperature variation of the magnetization between 20° and 500°K and in fields up to 2×10^4 oersted. The Curie point is at 486°K. The magnetic hardness coefficient is large at low temperatures (980 at 260°K) and below 200°K the hyperbolic law of approach to saturation is no longer valid. Measurements on a single crystal along three crystallographic axes enable the anisotropy energies to be determined at 20°K and room temp. E. P. WOHLFARTH

538.221

3656. The influence of the ionic diameters of the rare earths on the ferromagnetic properties of their ferrites. G. GUIOT-GUILLAIN. *C.R. Acad. Sci* [*Paris*] **237**, 1654–6 (*Dec.* 21, 1953) *In French.*

It is found that parabolic relations exist between the Curie temperatures of rare earth ferrites ($Fe_2O_3.M_2O_3$) and the ionic diameters of the metals. The existence of two Curie points for those ferrites for which M = Y, Sm, Gd, Tm, Yb is explained. E. P. WOHLFARTH

538.221

3657. Magnetic resonance in ferrimagnetics. R. K. WANGSNESS. *Phys. Rev.*, **93**, 68–71 (*Jan.* 1, 1954).

It is shown that the general expression for the magnetic resonance frequency of the two-sublattice model of a ferrimagnetic crystal has essentially the same form as that originally obtained for the ferromagnetic case provided that the product of the molecular field coefficient and the net magnetization is large compared to the applied and anisotropy fields. The special cases of vanishing magnetization and angular momentum are considered separately, and the relation of these results to the theory of antiferromagnetic resonance is discussed. A.

538.221

3658. Magnetic viscosity due to fluctuations. J.-C. BARBIER. *Ann. Phys.* [*Paris*] **9**, 84–140 (*Jan.–Feb.*, 1954) *In French.*

A comprehensive account of experimental work

guided by the theory of the effect due to Néel [Abstr. 4211 (1950)]. The theory is briefly discussed and the apparatus used is described. The results of weak field measurements of the irreversible change of magnetization with time are given for an Alnico specimen, and the results are interpreted. The measurements are extended to cover the complete hysteresis cycle and are carried out on a range of ferromagnetic substances with widely differing coercive fields. The change of magnetization due to a slight annealing treatment, the application of an alternating field and the application of external compression is measured. The theoretical treatment of these changes is formally equivalent to that of irreversible changes of magnetization with time. The magnetic losses in a variable magnetic field are studied, both rotating and alternating fields being investigated. The total loss contains, apart from hysteresis and eddy current loss components, a component due to irreversible magnetic viscosity.

E. P. WOHLFARTH

538.221

3659. Ionic distribution deduced from the *g*-factor of a ferrimagnetic spinel: Ti^{4+} in fourfold co-ordination. E. W. GORTER. Letter in *Nature* [*London*] **173**, 123–4 (*Jan.* 16, 1954).

Shows that the distribution of the metallic ions among the two available types of lattice sites in oxides with a spinel structure may be deduced from a knowledge of the saturation magnetization and the spectroscopic splitting factor. For $Ni_{1\cdot5}FeTi_{0\cdot5}O_4$, $p_B = 1\cdot45$ and $g = 2\cdot90$ at 0°K, giving the distribution $[Fe_{0\cdot7}Ti_{0\cdot3}]_A[Ni_{1\cdot5}Fe_{0\cdot3}Ti_{0\cdot2}]_BO_4$. The presence of Ti^{4+} ions on the tetrahedral *A* sites is noted.

E. P. WOHLFARTH

538.221 : 535.343–14

3660. Ferromagnetic resonance in parallel wires as a function of temperature and hysteresis. A. G. KOTOV. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 3, 373–5 (1952) *In Russian.*

Loss measurements are made on // wires at 8·1 and 3·1 cm with fields up to 1200 Oe and up to 125°C. Ni above 75°C shows antiresonance, that is a minimum of the loss occurs at 260 Oe. Fe shows hysteresis, a change of loss and a small change of the field strength for max. loss being apparent between increasing and decreasing the magnetic field. D. H. WHIFFEN

538.221 : 537.534 : 621.374.32 : 621.318.1

Properties of ferromagnetic ferrites. *See Abstr.* 3568

538.221 : 538.23

3661. Investigations of the ageing processes in permanent magnet alloys. K. J. KRONENBERG. *Z. angew. Phys.*, **5**, *No.* 9, 321–9 (1953) *In German.*

Reports measurements on the following alloys: W–H steel, Alni 120 (cast, sintered), Alnico (anisotropic), powder magnet. The following physical changes were investigated: effects on remanence of application of alternating fields of amplitude about $0\cdot1\ H_c$, effects of repeated application of d.c. fields, of flux closure by means of soft iron yokes, effects due to repeated mechanical shock and due to tempering at various temperatures. The remanence changes taking place over a long period of time (up to 1 year) in undisturbed samples were also investigated.

E. P. WOHLFARTH

538.221 : 538.65

3662. Effect of cross-section area and compression upon the relaxation in permeability for toroidal samples of ferrites. R. E. ALLEY, JR AND F. J. SCHNETTLER. Letter in *J. appl. Phys.*, **24**, 1524–5 (*Dec.*, 1953).

Complex permeability measurements on a toroidal sample, the cross-sectional area of which was reduced in stages by grinding, show that for MnZn ferrite the relaxation frequency increases as the area is reduced, whilst for NiZn ferrite it is independent of the area. This suggests that in MnZn ferrite the relaxation is due to dimensional (eddy current, etc.) effects rather than to domain wall motion. This conclusion is supported by observation of the effect of compressional stress. A. E. DE BARR

538.222/.224

3663. A calculation of the diamagnetic and paramagnetic susceptibility of N_2 by the statistical method. J. V. BONET AND A. V. BUSHKOVITCH. *J. chem. Phys.*, **21**, 2199–201 (*Dec.*, 1953).

The diamagnetic and the paramagnetic terms in the susceptibility of N_2 are calculated using the statistical method of Thomas and Fermi corrected for exchange and correlation effects. A statistical electron density of N_2 corrected for exchange and correlation, is used in the evaluation of the integral $\int \rho r^2 dv$, which defines the mean square position of the electronic charge of the molecule appearing in the diamagnetic term. A statistical distribution function of the square electronic angular momentum of the molecule is derived, and the mean square electronic angular momentum of the molecule, appearing in the paramagnetic term, is defined in terms of the distribution function. This procedure leads to a result which, although approximately two times larger than the observed value, still is fully as good as similar calculations for atoms. A.

538.222

3664. Magnetic birefringence of paramagnetics under resonance conditions. A. BATTAGLIA, A. GOZZINI AND E. POLACCO. Letter in *Nuovo Cimento*, **10**, 1205–6 (*Aug.*, 1953) *In Italian.*

The TE_{11} mode was excited in a circular waveguide containing a paramagnetic salt in a static magnetic field orthogonal to the axis of the guide. The magnetic vector of the impinging wave was inclined at 45° to that of the static field, so that it split into components parallel and perpendicular to the static field, with different complex refractive indices in the paramagnetic salt. The polarization of the emergent wave was examined as a function of the strength of the static field, and results demonstrating the birefringence of $MnSO_4$ at and near to paramagnetic resonance are presented. R. S. PEASE

538.222

3665. Some cobalt and iron compounds with a low constant paramagnetic susceptibility. A. SERRES. *J. Phys. Radium*, **14**, 689–90 (*Dec.*, 1953) *In French.*

Reports susceptibility measurements on two La-rich alloys with Co (between 20° and 620°C), on the

two modifications of FeS_2 (up to 200°c) and some other compounds. The value of χ_A for the Fe and Co ions in these substances is $\sim 80\times10^{-6}$, independent of temperature. E. P. WOHLFARTH

538.222

3666. Hyperfine splittings in the paramagnetic resonances of free radicals. S. I. WEISSMAN, J. TOWNSEND, D. E. PAUL AND G. E. PAKE. Letter in *J. chem. Phys.*, **21**, 2227–8 (*Dec.*, 1953).

19 hyperfine components are observed for the naphthalene negative ion, 10 for difluorenyl nitrogen, 33 for Wurster's blue and 4 for sodium trimesityl boron, in the paramagnetic resonance at 9000 Mc/s near 3200 Oe. They must arise from interaction with H and B spins, but the coupling should be zero for the planar naphthalene negative ion though zero-point vibrations may affect this conclusion.

D. H. WHIFFEN

538.222

3667. On the problem of evaluating the times of spin-spin relaxation and of inherent magnetic fields. YU. YU. SAMITOV. Letter in *Zh. eksper. teor. Fiz.*, **23**, *No.* 6 (12) 734–6 (1952) *In Russian.*

The expression developed by Shaposhnikov for the complex portion of the paramagnetic susceptibility at $H = 0$ (1949) and the Al'tshuler *et al.* formula (1947) were used to determine the values of $\tau_s(0)$ and H_i for fourteen powdery substances of the elements of the iron group. These values were found from the experimental curves of paramagnetic absorption at $\nu = 1\cdot554\times10^8$ c/s, and are compiled in a table together with the theoretical values, which are calculated on the assumption of purely dipole interaction.

E. RABKIN

538.222 : 539.132

Fluorine resonance shifts. *See Abstr.* 3731

538.222 : 539.152.2

3668. Theory and measurement of relaxation times in nuclear paramagnetic resonance. R. GABILLARD. *Rev. sci.* [*Paris*] **90**, 307–52 (*Sept.–Oct.*, 1952) *In French.*

A full account of the experimental method and theory with especial emphasis on the measurements of T_1 and T_2 by methods based on the "wiggles," which is still applicable when the inhomogeneity of the field is as high as 1/10 gauss to measure T_2 values as long as 10^{-1} sec. The limitations, resulting from noise in the magnetic field current and other sources, are discussed. T_2 for H_2O is given as a function of $Fe(NO_3)_3$ concentration from N to N/500.

D. H. WHIFFEN

538.222 : 539.185

Paramagnetic scattering of neutrons by rare earth oxides. *See Abstr.* 3895

538.222 : 621.37.029.6 : 535.33.07–15 : 538.565

Introduction to microwaves and their scientific applications. *See Abstr.* 3679

538.224

3669. The temperature variation of diamagnetic susceptibility. E. W. ELCOCK. *Proc. Roy. Soc. A*, **222**, 239–53 (*March* 9, 1954).

The temperature variation of a major contribution to the diamagnetic susceptibility of orbital electrons is calculated for various forms of the surfaces of constant energy in the neighbourhood of the Fermi surface in k space. Both quadratic and non-quadratic ε, k relations are considered. A discussion is given of the theoretical results in relation to the relevant experimental results and, in particular, in relation to the complicated variations of susceptibility with (*a*) temperature and (*b*) concentration for alloys of bismuth with low concentrations of added lead and tellurium. It is shown that the treatment provides a basis for a simple and direct correlation of the temperature-dependent and concentration-dependent magnetic properties for low-concentration diamagnetic alloy sequences. A.

538.224 : 539.132

3670. Anisotropy of the diamagnetic susceptibility of benzene, naphthalene and anthracene. M. V. VOL'KENSHTEĬN AND L. A. BOROVINSKIĬ. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 5, 977–80 (1952) *In Russian.*

Presents a new method of calculating the anisotropy of diamagnetic susceptibility, based on an elementary physical model of an electron in a potential box [Abstr. 8617 (1953)]. The expression $\chi = -(27a^2e^2/2\pi^2mc^2)N_A$ is obtained from the wave equation for an electron in a magnetic field. Assuming a to be $1\cdot39\times10^{-8}$ cm, we obtain for C_6H_6 (assumed to be a circular molecule) $\chi = \Delta\chi = -44\cdot7\times10^{-6}$ cm^3/mole, instead of the experimentally determined value of -54×10^{-6} cm^3/mole. Analogous calculations give, for naphthalene, $\chi = \Delta\chi = -113\cdot3\times10^{-6}$ (experimental -114×10^{-6}) cm^3/mole, and, for anthracene, $-305\cdot2\times10^{-6}$ (experimental -183×10^{-6}) cm^3/mole. F. LACHMAN

538.24 : 536.48

3671. Investigation of the effect of uniformly distributed pressure on the magnetic saturation of iron at the temperature of liquid nitrogen. F. GAL'PERIN, S. LARIN AND A. SHISHKOV. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 3, 419–22 (1953) *In Russian.*

The effect on its magnetic saturation of subjecting Armco iron to pneumatic pressure at 20 and −196°c has been measured. A definitely positive value was found for $(1/\psi_0)(d\psi/dp)$ (ψ, ψ_0 = magnetic currents at p and p_0 pressures respectively) of $0\cdot55 \pm 0\cdot25\times10^{-7}$ atm^{-1} at −196°, and of $0\cdot24 \pm 0\cdot1\times10^{-7}$ at 20°c, which contrasts with previous determinations giving either negative or zero values. This new value at −196° gives $-1\cdot39 \pm 0\cdot25\times10^{-7}$ atm^{-1} for $(1/\sigma_0)(dT/dp)$ (σ_0, σ = magnetic saturations at p_0 and p), which is in satisfactory agreement with a value of $-1\cdot49\times10^{-7}$ calculated theoretically from the formula for the atomic magnetic moment for pure ferromagnetic materials. R. C. MURRAY

538.24 : 621.318.2

3672. Permanent magnets. *Sheffield: Permanent Magnet Association* (1953) v + 54 *pp.*

Concise information is given on the choice and treatment of modern materials with tables and numerous curves showing their characteristics. Further sections deal with design, magnetizing, demagnetizing, and the effects of heat and shock on permanent magnets.

538.27

3673. The de Haas–van Alphen effect. D. SHOENBERG. *Physica*, **19**, 791–806 (*Sept.*, 1953).

A brief review of experimental data and theoretical interpretation. Includes an interim report on progress of experiments on Sn and Pb at very high fields by the electromagnetic induction method [Shoenberg, Abstr. 974 (1953)]. D. SHOENBERG

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

3674. The stability, in the sense of T. de Donder, of Maxwell's electromagnetic laws. H. DE SLOOVERE. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 2, 183–5 (1953) *In French.*

538.3 : 530.145

Electrodynamics without potentials. *See Abstr.* 3074

538.54 : 621.3.014.4 : 621.384.612 : 537.534

Eddy-current phenomena in the cosmotron. *See Abstr.* 3579

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56 : 621.3.011

3675. An identity leading to the solution of the Kirchhoff problem for damped waves. E. DURAND. *C.R. Acad. Sci.* [*Paris*] **237**, 647–9 (*Sept.* 28, 1953) *In French.*

The identity is stated and various transformations are made. It is then applied to the solution of the wave equation arising in Kirchhoff's problem. It may be used with second- or first-order equations.

L. S. GODDARD

538.561

3676. Plasma oscillations in magnetic field. G. V. GORDEEV. *Zh. eksper. teor. Fiz.*, **23**, *No.* 6 (12) 660–8 (1952) *In Russian.*

In the author's opinion, the method of investigation of longitudinal oscillations in the plasma in constant magnetic field, used by Akhieser and Pargamanik (1948), leads to inexact results, especially in determining the attenuation. Therefore the author conducts his analysis *ab initio*, beginning from the linearized system of two fundamental equations for such oscillations in vectorial form. The first equation states that the complete differential of the velocity distribution, as a function of electric and magnetic fields and the thermal motion, is zero; the second is the continuity equation. These equations are then transformed into analytical form with reference to cylindrical co-ordinates with the axis of symmetry orientated along the magnetic field, assuming a sinusoidal dependence upon the time and the axial co-ordinate. By using a number of transformations involving Fourier integrals with a complex variable frequency, and Bessel functions, an expression is obtained for the electric field and for the momenta of the particles for the Fourier components, as a function of the radial and the angular co-ordinates. The expression for the electric field contains a number of singularities, and the determination of these singularities yields the "dispersion equation," i.e., the frequencies and the decrements as functions of wavelength. In the limiting case, where the magnetic field becomes zero, this equation gives the Landau equation which was evolved for this particular condition [Abstr. 353 (1947)]. From the analysis of his dispersion equation the author arrives at the conclusion that the longitudinal magnetic field influences the frequencies and the decrements only indirectly, by affecting the parameters of the discharge and thus influencing the temperature and the concentration of the electrons. In this way a very strong magnetic field should cause an anomalous dispersion (i.e., a fall of the frequency with the wavelength); it can also produce self-excitation of the oscillations.

N. S. JAPOLSKY

538.561 : 537.525.8

3677. Self-excitation of the oscillations in the positive column of the gas discharge. M. E. GERTSENSHTEĬN. *Zh. eksper. teor. Fiz.*, **23**, *No.* 6 (12) 669–77 (1952) *In Russian.*

The problem is limited to finding the necessary and sufficient conditions for the generation of the auto-oscillations in the positive column of gas discharge in the absence of active resistance. The analysis begins from the equation expressing the stationarity of the velocity distribution of free electron and positive ions in the form used by Vlassov (the "Vlassov equation") and the Maxwell equations, both in vectorial form. These equations are then inter-combined and brought into the analytical form with reference to cylindrical co-ordinates, co-axial with the column, assuming the exponentially periodic dependence of the e.m. field upon the axial co-ordinate and the time. The solution of these transformed equations yields the velocity distribution of the free electrons and positive ions, the conduction currents, and the equivalent dielectric constants $\varepsilon(\omega,\kappa)$, for the component waves of the Fourier series defined by their respective wave parameters ψ and angular frequencies ω. The dispersion law of the longitudinal waves formed by charged particles is determined by $\varepsilon(\omega,\kappa) = 0$. This equation involves contour integrals, which the author analyses graphically by means of contoural curves (hodographs) drawn as functions of complex variable ε for given parametrical values of the phase velocity of the component wave, $u = \omega/\kappa$. The parameters of self-excited oscillations can be then found, in a conventional way, from the intersection points of the hodographs with the real axis. The author points out that in the actual discharge tubes, as distinct from the ideal positive columns, the auto-oscillations can also be caused by the influence of the walls upon the radial distribution of the electron and ion concentration. N. S. JAPOLSKY

538.561 : 621.373.42

3678. Developments in frequency synthesis. H. J. FINDEN. *Trans Inst. Meas. Conf.*, **1952**, 166–74.

Describes a frequency synthesizer generating frequencies in the range 1 kc/s–100 Mc/s, such that

frequencies can be selected at 1 kc/s steps throughout the range, with a maximum sideband component of 0·05%. The results of an investigation of the strengths of components obtained with a linear multiplicative mixing system combined with various filters are given. G. D. SIMS

538.565 : 535.33.07–15 : 538.222 : 621.37.029.6

3679. Introduction to microwaves and their scientific applications. [Einführung in die Microwellen und ihre wissenschaftlichen Anwendungen]. H. H. KLINGER. *Stuttgart: S. Hirzel* (1954) viii + 117 *pp. In German.*

A brief introductory account, with 90 figures, of microwave circuits and components and their applications to gas spectroscopy, para- and ferromagnetic resonance, anomalous dispersion, astrophysics, electron accelerators, etc. D. H. WHIFFEN

538.565 : 537.525.8

The dispersion formula for plasma waves. *See Abstr.* 3526

538.565 : 621.372.41

3680. Strong perturbations of natural electromagnetic oscillations in nearly cylindrical regions. YU. S. SAYASOV. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 2, 163–6 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-78.*

A study of the effect of small deformations on the natural modes of circular TM_{0pn} resonators. The magnitude of the field perturbation for a given eccentricity is dependent on a factor of the order of the square of the ratio of the length of the resonator to its diameter. G. D. SIMS

538.566

3681. The propagation of electromagnetic waves over a plane having uniform anisotropic surface conditions. M. A. MILLER. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 4, 571–4 (1952) *In Russian.*

The anisotropy is specified by two complex impedances, which may be regarded as components of a tensor. The case of cylindrical waves is considered. The different types of asymmetrical waves are briefly discussed. H. H. HOPKINS

538.566

3682. The problem of the scattering of electromagnetic waves on a rough surface. YU. P. LÝSANOV. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 5, 719–22 (1952) *In Russian.*

538.566

3683. Equations for the reflection coefficients of waves on a periodically rough surface. L. N. DERYUGIN. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 6, 913–16 (1952) *In Russian.*

538.566

3684. On the vectorial modifications inherent in the Doppler effect for [plane] waves propagated in a [moving] dielectric medium. M. RISCO. *J. Phys. Radium*, **14**, 657–62 (*Dec.*, 1953) *In French.*

It is noted that the transformation properties from a rest frame Σ to a moving frame Σ' of the induction vectors **D**, **B** and the momentum vector **G** may be derived from those for the intensities **E**, **H** and the Poynting vector **S** by replacing the refractive index n by $1/n$. The conditions under which a frame Σ' may be found in which the field is stationary are investigated, and the physical significance of the velocities cn and c/n is discussed. R. A. NEWING

538.566 : 621.372.8

3685. Theory and applications of surface waves. F. J. ZUCKER. *Nuovo Cimento*, **9**, *Suppl. No.* 3, 450–73 (1952).

"Free" waves are defined as those whose propagation constant is independent of the source. The nature of such waves in open guides—dielectric cylinders, wires with dielectric beads, dielectric-filled spirals, etc.—are discussed. In general both transmission and radiation modes may exist, their forms depending on the transverse propagation constants of the guide. An outline is given of the theoretical treatment which provides the required discrete and continuous eigenvalues. Examples are given of open guides in which transmission is observed in the microwave region. Analogous optical waves are discussed and it is suggested that Zenneck waves on flat metallic sheets are free waves and may yet be observed experimentally. D. H. WHIFFEN

538.566 : 621.372.8

3686. The excitation of plane surface waves. A. L. CULLEN. *Instn Elect. Engrs Monogr. No.* 93, 10 *pp.* (*Feb.* 15, 1954) [To be republished in *Proc. Instn Elect. Engrs IV*].

It is shown that a surface wave will be generated by a horizontal slot situated above a corrugated or dielectric-coated guiding surface. A physical interpretation of the analysis is suggested which explains the mechanism of launching in terms of a resonance phenomenon allied to that which arises when a piston attenuator is terminated by a reactance equal and opposite to its own (reactive) characteristic impedance. The problem of efficient launching is discussed, and it is shown that under suitable conditions a high launching efficiency is possible. Some of the theoretical predictions have been verified experimentally. A.

538.566 : 621.396.67

3687. Super-gain antennas and optical resolving power. G. TORALDO DI FRANCIA. *Nuovo Cimento*, **9**, *Suppl. No.* 3, 426–38 (1952).

The principle of super-gain microwave aerials, which appears to contradict the optical resolving power limit (Rayleigh limit), is applied to the optical case. It is shown, theoretically, that arbitrarily high resolving power, at the expense of available energy, may be obtained by appropriate limitation of the diffraction pattern with circular stops at an intermediate focus. The relationship of this result to Heisenberg's uncertainty principle is raised. D. H. WHIFFEN

538.566 : 621.396.67

3688. Radiation from a line source adjacent to a conducting half-plane. J. R. WAIT. Letter in *J. appl. Phys.*, **24**, 1528–9 (*Dec.*, 1953).

The line source is parallel to the axis of the half-plane, and carries either an electric or a magnetic current. The solution is completely specified in terms of circularly cylindrical harmonics, the Bessel

functions being of half-integral order. See also Abstr. 6964 (1953). T. J. REY

538.566.2 : 523.746

3689. Bailey's theory of sunspot noise. J. W. DUNGEY. *J. atmos. terrest. Phys.*, **4**, 148–62 (*Dec.*, 1953).

The exact formulation of Bailey's theory [Abstr. 5590 (1949)] for a non-uniform ionized gas is described and the boundary conditions are explained. A direct calculation is made of the rate of exchange of energy between the motion of the electrons and the wave. The intensity of the radiation arising from a transient disturbance is calculated and it is found that the intensity can become very large when the wave gains energy from the electrons. The general nature of the electron flow and the order of magnitude of the electron velocity needed for amplification to occur are discussed. A.

538.566.2 : 523.746

3690. The equations for a problem arising in Dungey's investigation of Bailey's theory of sunspot noise. R. E. LOUGHHEAD. *J. atmos. terrest. Phys.*, **4**, 163–74 (*Dec.*, 1953).

In the preceding investigation of wave amplification, Dungey has paid particular attention to the possibility of wave amplification in an axially symmetric model of the solar atmosphere over a sunspot. In the present paper the differential equations of a small radiation field in a non-uniform ionized gas are shown to possess particular solutions, which, along the axis of symmetry, correspond to ordinary circularly polarized waves. By taking one of these solutions subject to the condition that there be no net radial flow of wave energy either into, or away from, the axis, the equations relating the electric vector e_0 of the wave along the axis and the associated electron velocity u_0 are found. These equations form the starting point of Dungey's investigation of wave amplification in the axially symmetric model. A.

538.566.3

3691. The scattering of radiowaves by the local non-homogeneities in the plasma of the ionosphere. M. E. GERTSENSHTEĬN. *Zh. eksper. teor. Fiz.*, **23**, *No.* 6 (12) 678–81 (1952) *In Russian.*

The analysis is limited to the case where the dimensions of the zone of the local non-homogeneity are much smaller than the wavelength. It begins from the wave equation combined with the hydrodynamic equation, applied to the ionized medium. In the case of plane longitudinal waves in the plasma, these two equations lead to a combined equation for the distribution of the density of the electric charge, for which the formal solution can be found. However, the solution of the problem cannot be completed without further assumptions, owing to the lack of knowledge of the properties of the medium. Nevertheless, in the opinion of the author, it is reasonable to apply in this case the expressions for the average energy density and the average energy flux density (the Poynting vector) obtained independently by C. M. Rytov (1947) and by V. N. Kessenikh (1941). From the complete solutions obtained by applying these relationships, the author concludes that the power carried away by the longitudinal wave exceeds 10^7 to 10^{10} times the power carried away by the transverse waves, and therefore the latter can be neglected. N. S. JAPOLSKY

538.566..

3692. Group velocities and group heights from the magneto-ionic theory. D. H. SHINN AND H. A. WHALE. *J. atmos. terrest. Phys.*, **2**, *No.* 2, 85–10 (1952).

The group velocity of a radio wave in the ionosphere above south-east England is calculated for the ordinary and extraordinary wave for a wide range of frequencies. Results are presented in the form of curves. A sufficient number of values has been calculated for group delays at vertical incidence to be computed. Similar values for various angles of dip are used to find the shapes of the group height–frequency curves, for the ordinary ray vertically incident on a parabolic layer, at various magnetic latitudes. Estimates of height of maximum ionization and thickness of layer from observed group height v. frequency curves have until now been based on calculations in which the effect of the magnetic field is neglected. It is shown that such estimates of layer thickness are correct on the magnetic equator but yield values which are too high by about 17% at magnetic latitude 27° rising to about 53% at magnetic latitude 62°. Estimates of height of maximum ionization are, however, approximately correct. A modification to the present method of estimating these parameters is proposed. The effect of the field on oblique incidence propagation is discussed, but no exact conclusions are reached. A.

538.566.3 : 535.51

3693. Birefringence in crystals and in the ionosphere. C. H. M. TURNER. *Canad. J. Phys.*, **32**, 16–34 (*Jan.*, 1954).

Propagation of plane electromagnetic waves in a homogeneous ionized gas in a uniform magnetic field is compared with the propagation of light in an optically inactive birefringent crystal. It is well known that propagation in a crystal may be described by using a system of real orthogonal axes for which the dielectric constant is given by a diagonal matrix. This paper shows that propagation of plane waves in the ionosphere may be described in a similar manner, the medium having an effective dielectric constant given by a diagonal matrix, provided that a system of "complex" orthogonal axes is used for the description of the components of the field vectors. This set of component axes (which is quite different from and not to be confused with coordinate axes) is equivalent to resolving the field vectors into components parallel to the magnetic field and two contra-rotating circular components in a plane perpendicular to the magnetic field. An expression giving the velocity of each of the two modes of propagation in a given direction and expressions for the amplitude of each component of the field vectors are obtained. Provided that one accepts the concept of a complex velocity of propagation, the results hold when electron collisions are included. When electron collisions are neglected, it is possible to form a double-sheeted surface, called the normal velocity surface, which is

of some assistance in visualizing the manner in which the velocity of propagation of the plane waves in each mode changes with direction. A.

538.566.3 : 551.510.535

3694. On the double refraction of the ionosphere. R. W. LARENZ. Note in *Naturwissenschaften*, **40**, *No.* 20, 527 (1953) *In German.*

Short note on the physical interpretation of certain features of the Appleton–Hartree magneto-ionic dispersion formula. W. J. G. BEYNON

MAGNETIC EFFECTS 538.6

538.632 : 548.7

3695. Hall effect in AgCl at low temperatures. F. C. BROWN. Letter in *Phys. Rev.*, **92**, 502 (*Oct.* 15, 1953).

A modification of the Redfield method [see Abstr. 8600 (1953)] is used to measure Hall mobility in AgCl at 87°K. The crystal is insulated from the electrodes and excited by a 15 μsec light pulse synchronized with a slower electric field pulse applied to the crystal. Steady low-intensity illumination avoids polarization effects. Mobility values are reproducible and agree with those from electron drift measurements.

G. F. J. GARLICK

538.65

3696. Investigation of the ΔE-effect and the damping of elastic waves in polycrystalline nickel using an acoustic method. V. P. SIZOV. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 3, 427–30 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-*31.

Young's modulus E and the decrement of damping of longitudinal waves were evaluated from the fundamental resonant frequency (12–12·5 kc/s) and width of the resonance curve, measured in magnetic fields of up to 1215 Oe on 199·75 mm long, 5·95 mm dia. rods of 99·5% pure nickel (*a*) annealed at 1000°C and (*b*) oil-quenched from 1150° to 10°C and cold-rolled. E increases with magnetic field, reaching a maximum at 540 Oe for specimens (*a*) and at 675 Oe for specimens (*b*), the increase, ΔE, for specimens (*b*) being 25% less than for specimens (*a*). $\Delta E/E$ is shown to be proportional to the square of magnetization $(J/J_s)^2$; when the displacement of I_s regions is changed into rotation [at $(J/J_s)^2 = 0{\cdot}64$] there is an abrupt change of slope for specimens (*a*) and a gradual one for specimens (*b*). Damping in specimens (*a*) decreases rapidly with an increase of magnetic field; in specimens (*b*) it first increases, reaching a maximum at 30 Oe (minimum E) and then equally rapidly decreases. The smaller amplitude of vibration and increased damping in specimens (*b*) are related to the lowering of the maximum of the ΔE effect, which is an even effect. A. GELBTUCH

538.653.11

3697. Change of magnetization under uniform elastic compression. P. T. ORESHKIN. *Zh. eksper. teor. Fiz.*, **23**, *No.* 6 (12), 728–30 (1952) *In Russian.*

Polemical. Galperin's [Abstr. 8868 (1951)] adduction of the author's published experimental results for the change of magnetization of iron under pressure, as support for formulae which he has deduced for this change, is not considered to be valid (*a*) because his formulae can be satisfied by different (and divergent) sets of results, and (*b*) because he applies his formulae not to the change of magnetic saturation σ_∞ with pressure, but to that of σ_s. R. C. MURRAY

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

3698. A contribution to the theory of multivalent metals. E. ANTONČÍK. *Czech. J. Phys.*, **2**, 31–5 (1953).

Deals with the extension of the statistical model of metals having one or two valency electrons as suggested by Gombás [Abstr. 8969 (1952)] to multivalent metals. On the basis of this model a number of constants of metallic aluminium were calculated without using any empirical parameters. The results are in comparatively good agreement with experiment. A.

539.11

3699. The electron theory of metallic aluminium. E. ANTONČÍK. *Czech. J. Phys.*, **2**, 18–29 (1953) *In Russian.*

The wave function of the valency electrons of metallic aluminium are determined by means of an approximate method suggested by Matyáš [Abstr. 8968 (1952)]. By means of two experimentally determined facts, i.e. the lattice constant and the space group of metallic aluminium, the energy in a number of points of the first and second or third Brillouin zone was calculated and the curve $2N(\eta)$ was approximately determined. It was shown that the theoretical value 0·900 *Ry* for the Fermi limit agrees well with the value measured by Skinner [1940], $0{\cdot}867 \pm 0{\cdot}037$ *Ry*. On the basis of the energetic spectra thus determined the binding energy of aluminium was calculated which is in good agreement with the experimental value reduced to $T = 0$°K. The numerical agreement of the two values should, however, be considered an accident due to the approximate character of the method. Further, the emission spectra of the soft X-ray radiation was interpreted and some changes in the trend of the lattice constant of solid solutions of aluminium, especially the solid solution with zinc, were explained. The latter was compared with the measurements of Ellwood. A.

539.11

3700. The origin of metallic properties in ionic and valence crystals. H. KREBS. Note in *Naturwissenschaften*, **40**, *No.* 20, 525–6 (1953) *In German.*

By considering p-like electronic states on Pb and S atoms in cubic PbS crystals, a valence bonding scheme with spins on neighbouring atoms being coupled is proposed. Resonance of this structure with the ionic states may give metallic properties.

Bi, As and Sb are iso-electronic with PbS and form a distorted rock-salt lattice. Similar arguments are applied to the metal-like character of TiO, TiN and TiC, and to the antiferromagnetism of PtS_2, $NiTe_2$ and $CoTe_2$. W. M. LOMER

539.11

3701. Calculating of the cohesive energy of di d. L. A. SCHMID. *Phys. Rev.*, **92**, 1373–9 (*De* 5, 1953).

It is well known that a satisfactory value for the binding energy of the hydrogen molecule may be calculated using a wave function which has the form of a Heitler–London (HL) function built on non-orthogonal orbitals. However, Slater has shown that a HL function built on orthogonal orbitals fails to yield any binding for the hydrogen molecule, but binding may be achieved by mixing with the HL function an ionized-molecule function which assigns two electrons to one atom and none to the other. Satisfactory results may also be achieved using a Hund–Mulliken (HM) function which may be built on either orthogonal or non-orthogonal orbitals, since the wave functions resulting in these two cases may be shown to be identical. The present calculation shows that the situation for diamond is entirely analogous to that for the hydrogen molecule in that the usual formulation of the Slater–Pauling (SP) directional theory of valence, which is a generalization of the HL method using orthogonal orbitals, fails to yield any binding, but satisfactory results are achieved when this theory is reformulated to allow ionization to be introduced into the bonds. It is also shown that for the observed value of the lattice parameter, which is the only value for which the calculations have been performed, satisfactory results are also achieved using a wave function which is built on orthogonal HM orbitals, each of which, like its counterpart in the hydrogen molecule case, is spread out over a pair of bonded atoms. As a by-product of the main calculation, the total exchange energy of Bloch-type functions belonging to the valence bands of diamond is calculated and found to be essentially equal to the value obtained using free-electron functions. A.

539.11 : 537.221

Theory of contact electrification. *See Abstr.* 3425

539.11 : 538.21

3702. The magnetic properties of an electronic Einstein model solid. M. F. M. OSBORNE AND M. C. STEELE. *Phys. Rev.*, **92**, 1403–19 (*Dec.* 15, 1953).

Following Einstein's proposal for a thermodynamic description of the ions in a solid, a model is proposed for the electrons in a solid where the electrons are confined to parabolic wells and, within each well, obey Fermi statistics. The parameters of the model are ω_0, the classical frequency; m, the mass; n_e, the number of particles per well; and n_ω, the number of wells per unit volume. In terms of these parameters the magnetic and caloric properties of the model can be unambiguously evaluated. This gives a satisfactory and consistent description of the thermodynamic properties of superconductors and of paramagnetic salts when appropriate values of the above parameters are determined. A.

MOLECULAR STRUCTURE 539.13

539.13/.132 : 541.1

3703. Homogeneous gas processes and time de pendent perturbation theory. H. AROESTE. Letter in *J. chem. Phys.*, **21**, 1897–8 (*Oct.*, 1953).

The possibility of a unified theory of intra- and intermolecular gas processes is considered on epistemological grounds. The total Hamiltonian is $H = H_0 + V$ where H_0, the unperturbed Hamiltonian, and V, the perturbation term, have to be chosen. For intermolecular processes the natural choice of V is the interaction between the molecules but for intramolecular processes the choice is much more arbitrary and may indeed be too large for the theory to be valid. Also $t = 0$ may be approximately specified for intermolecular processes as the time at which the two systems are brought together, but for intramolecular processes the perturbation has lasted for all time. Further similar arguments distinguish the two cases, the theory being more significant for intermolecular processes. H. H. GREENWOOD

539.13 : 533.1

The self-diffusion of N_2 and CO_2 at high pressures. On the additivity of intermolecular forces. *See Abstr.* 3182

539.13 : 533.7

3704. Theory of intermolecular potential and second virial coefficient of hydrogen at low temperatures. M. MIZUSHIMA, K. OHNO AND A. OHNO. *J. chem. Phys.*, **21**, 2107–14 (*Dec.*, 1953).

The intermolecular potential between hydrogen molecules is calculated taking into account its dependence on the relative orientation of the molecules. Assuming that the rotational quantum number of each molecule is a good quantum number throughout a collision at low temperature, the matrix elements of the repulsive short range intermolecular potential and the London potential are calculated. If the intermolecular potential depends on the relative orientation of colliding molecules, the resulting matrix element depends on the rotational quantum number. Thus it is pointed out that the second virial coefficient of ordinary hydrogen (which is, at low temperature, a mixture of 75% of $J = 1$ molecule and 25% of $J = 0$ molecules, where J is the rotational quantum number), and pure *para* hydrogen (which consists of only $J = 0$ molecules at low temperature) must be different, even if there were no statistical effect. The virial coefficient is calculated for very low temperatures by solving the Schrödinger equation numerically. A.

539.13 : 535.566 : 536.42

3705. On the dipole rotation of long-chain aliphatic alcohols in their various solid phases. G. KREMMLING. *Z. Naturforsch.*, **8a**, 708–16 (*Nov.*, 1953) *In German.*

The change of refractive index with temperature of *n*-tetradecyl- and *n*-cetyl-alcohol, investigated between 20° and 60°C, shows that these solid alcohols pass through several phases just below their melting points. The change in density at the transition points was calculated from the molecular refraction. From measurements of the orientation polarization it was found that the molecular rotation was not

ffected by the α–β_2 transition which occurs in lcohols with more than 12 C atoms. The moments s found from the molecular polarization showed no iscontinuity when setting into the glass-like phase. Accordingly at the transition from associated complexes into stretched double molecules the orientation with respect to the field direction is such, that the original moment is unchanged. Measurements of dispersion showed that the mobility of the molecules is greater in the glass-like than in the liquid phase. The distinction between the two phases becomes vaguer with increase of chain length. A. J. TAYLOR

539.13 : 539.181

3706. On the direct measurement of the effective collision radii of potassium with chlorine and other gases. N. SASAKI AND K. KODERA. *Mem. Coll. Sci. Univ. Kyoto A*, **25**, 83–6 (*Oct.*, 1949).

The method of molecular beams has been used by the authors for establishing the existence of the influence of chemical reactivity on the effective collision radius, using Na and K atomic beams in N_2, O_2, A and Cl_2. Results obtained are tabulated and discussed. The general conclusion is that, for K, the effective collision radius is not increased by chemical reactivity; the large-angle (kinetic) scattering brings about, for Na, the chemical reaction between Na and Cl_2. F. LACHMAN

539.132

3707. Force constants for the BF_3 molecule. V. SANTHAMMA. Letter in *Curr. Sci.*, **22**, 298 (*Oct.*, 1953).

These have been calculated, on the assumption of a planar symmetrical molecule, by use of Wilson's F and G matrices. The stretching constant was got by Badger's rule. Three of the four remaining constants were obtained from the infrared and Raman spectra of $B^{11}F_3$. Of the resulting two sets of constants, one was used to calculate the frequencies of $B^{10}F_3$, good agreement with experiment being found. A. J. TAYLOR

539.132

3708. Note on a nitrogen molecule calculation. M. WOLFSBERG. *J. chem. Phys.*, **21**, 2166–9 (*Dec.*, 1953).

Recent calculations of the binding energy of the nitrogen molecule carried out by Kopineck [Abstr. 8373 (1952)] are examined by means of molecular orbital calculations. The Hellmann–Kopineck procedure of omitting certain permutations in a valence bond procedure is investigated. It is concluded that the Kopineck calculation should not be used as an argument favouring the 9·8 eV value for the binding energy (D_0^0) of the nitrogen molecule. A.

539.132

3709. The dissociation energy of oxygen. P. BRIX AND G. HERZBERG. Letter in *J. chem. Phys.*, **21**, 2240 (*Dec.*, 1953).

New measurements of Schumann–Runge bands to $v' = 21$ give a convergence limit at $57127{\cdot}_5 \pm 5\ cm^{-1}$. The value for $D(O_2)$ at $41261 \pm 15\ cm^{-1}$ or $5{\cdot}114_8 \pm 0{\cdot}002$ eV now agrees with that from the $^3\Sigma_u^+ - {}^3\Sigma_g^-$ system. A. G. GAYDON

539.132 : 536.65

3710. On the heat of dissociation of carbon monoxide, latent heat of sublimation of carbon, atomic heat of formation of methane and the state of carbon atom in the methane molecule. M. S. SODHA. Letter in *Sci. and Culture*, **19**, 45–6 (*July*, 1953).

Calculation of data available in the literature yields 4 values for each of the 3 magnitudes; D_0 is found to be $= 362 \pm 2$ or 391 ± 2 kcal if the C atom in CH_4 is assumed to be in the ^3P or ^1D state, respectively. The author accepts Gaydon's value for $D_0(CO)$ and gives preference to the latter alternative. F. LACHMAN

539.132

3711. Vibration spectra of linear polymers. L. I. VIDRO AND M. V. VOL'KENSHTEĬN. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 6, 1243–6 (1952) *In Russian.*

See also Abstr. 5627 (1953). Derives expressions for intensities of the C–C bond vibrations in the Raman spectra of linear polymers; for some C_nH_{2n+2} hydrocarbons the expression is in qualitative agreement with experimental results obtained for their Raman spectra. F. LACHMAN

539.132

3712. The relation between vibration-frequencies of isotopic molecules. (Rule of sums of products.) L. M. SVERDLOV. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 3, 513–16 (1952) *In Russian.*

See Abstr. 8628 (1951). Apart from Redlich's product rules, relationships exist connecting only the frequencies of isotopic-substituted molecules; for the kinematic coeffs. of such a system are not linearly independent. A general formula connecting sums of products of squares of frequencies of a system of such molecules is established and verified for deuterated ethylenes. J. JACOBS

539.132

3713. On the work of P. G. Maslov "Method for the solution of systems of homogeneous linear equations in the calculations of the vibration of polyatomic molecules." P. G. MASLOV. Letter in *Zh. eksper. teor. Fiz.*, **23**, *No.* 6 (12) 736 (1952) *In Russian.*

The author states that the title of his paper may have been somewhat misleading and the object of the work was to establish a method for the expansion of the frequencies in terms of the molecular parameters τ ($\tau = K_{ij}^*$) and a_{ij}, but that he has used the method of Mayants [*Trudy Fiz. Inst., Akad. Nauk SSSR*, **5**, 171 (1950)] for the solution of the systems of homogeneous equations, after having simplified some of the final formulae, which shortened the calculations considerably. E. RABKIN

539.132

3714. Rotational isomerism of 1,2 dichloroethane and 1,2 dibromoethane. YU. A. PENTIN, YA. S. BOBOVICH, D. B. GUREVICH AND V. M. TATEVSKIĬ. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 3, 435–8 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-38.*

The Raman spectra have been recorded photoelectrically at various temperatures between 12 and 132°c. From the relative intensities of the two peaks in each spectrum corresponding to the C–halogen bond vibrations of the two isomers of each compound (at 654 and 754 cm^{-1} for dichloroethane, and

at 551 and 659 cm^{-1} for dibromoethane) at the different temperatures, a value close to 0 cal/mole was derived for the heat of isomerization of the dichloro, and of 770 ± 60 cal/mole for the dibromo derivative; this latter figure agrees well with some other published figures, and it is considered that the value of 2420 cal/mole, published by Frost (*Dokl. Akad. Nauk SSSR*, **60**, 387 (1948)] is erroneous.

R. C. MURRAY

539.132

3715. Relation of vibration frequencies of mono-substituted benzenes to those of benzene. S. N. GARG. Letter in *Curr. Sci.*, **22**, 298–9 (*Oct.*, 1953).

General correlations between the vibrational frequencies of C_6H_5X (X = atom or group) and those of C_6H_6 have been derived from the spectra of benzaldehyde and toluene. The rules are listed, and observed and calculated frequencies tabulated for ten molecules for which the molecular weight of $X \geqslant 15$. All assignments are checked by the Teller–Redlich product rule.

A. J. TAYLOR

539.132

3716. A sum rule for the vibrational frequencies of homologs. H. J. BERNSTEIN AND A. D. E. PULLIN. *J. chem. Phys.*, **21**, 2188–95 (*Dec.*, 1953).

It is shown empirically that the zero-point energy in substituted methanes may be treated as a constitutive property when account is taken of the interaction between non-bonded atoms. Thus, the sum of the vibration frequencies ($\Sigma\nu$) of the halogenated methanes is found to have the predicted quadratic dependence on the number of substituents. This reduces to a linear dependence in the case of isotopically substituted homologues, compared to the linear dependence for $\Sigma\nu^2$ found theoretically by Decius and Wilson, and Sverdlov. Both $\Sigma\nu$ and $\Sigma\nu^2$ give good agreement between observed and calculated results. Various applications are given for the $\Sigma\nu$ rule and it is shown further that $\Sigma\nu$, $\Sigma\nu^2$, $\Sigma 1/\nu$, $\Sigma 1/\nu^2$ are all approximately constitutive properties of the halogenated methanes.

A.

539.132

3717. Internal rotation in sulphur monochloride. N. W. LUFT AND K. H. TODHUNTER. Letter in *J. chem. Phys.*, **21**, 2225–6 (*Dec.*, 1953).

Analysis of the S_2Cl_2 spectrum cannot yet decide between C_2 and C_{2v} structures, but an angle of 90° between S–Cl bonds seems reasonable. If the Raman shift at 106 cm^{-1}, usually taken as the torsional fundamental, is reassigned as the first overtone of an unknown fundamental at 53 cm^{-1}, the unreasonably large potential barrier of 32 kcal/mole is reduced to 8 kcal/mole. The product of the moments of inertia depends little on the angle between the S–Cl bonds. The thermodynamic functions of the equivalent oscillator-rotator ideal gas, from 300°K to 1000°K, are calculated.

J. HAWGOOD

539.132

3718. The effect of nonrigidity on the line strengths of vibrational-rotational transitions. H. C. ALLEN, JR. *J. chem. Phys.*, **22**, 83–5 (*Jan.*, 1954).

The effect of the difference in asymmetry of the ground and excited states of a vibrational band on the line strengths of the vibrational-rotational transitions has been investigated. It is found that for sufficiently large $\Delta\kappa$ ($\sim 0{\cdot}1$–$0{\cdot}2$) in *A*- and *C*-type bands there is an enhancement of the line strengths of either the *R* or *P* branch, depending on whether or not κ of the ground state is greater or less than κ of the excited state. In *B*-type bands certain sub-bands are enhanced, but in general no branch of the band is enhanced as a whole.

539.132 : 535.329 : 535.343

Oscillator strengths of Br_2 vapour bands. *See Abstr.* 3306

539.132 : 535.338

3719. Intensities in $^4\Sigma$–$^4\Sigma$ transition. K. SUBRAHMANYANARAYANA RAO. *Indian J. Phys.*, **27**, 368–72 (*July*, 1953).

The intensity factors of the expected branches in a $^4\Sigma$–$^4\Sigma$ transition are calculated and the expressions are reduced to a convenient form. Representative theoretical intensity curves are drawn for three of the branches, using the data on columbium oxide previously published by the author.

A.

539.132 : 535.343–1

3720. Microwave measurement of D_0 for CO. F. D. BEDARD, J. J. GALLAGHER AND C. M. JOHNSON. *Phys. Rev.*, **92**, 1440 (*Dec.* 15, 1953).

The value of D_0 for $C^{12}O^{16}$ was determined as 189·0 ± 0·7 kc/s from measurements on the $J = 0 \rightarrow 1$ and $J = 1 \rightarrow 2$ rotational transitions. Also, the frequency of the $J = 1 \rightarrow 2$ line was determined as 230 536·59 ± 0·52 Mc/s.

A.

539.132 : 535.343–1

3721. Microwave spectra and structures of methyl mercury chloride and bromide. W. GORDY AND J. SHERIDAN. *J. chem. Phys.*, **22**, 92–5 (*Jan.*, 1954).

From the pure rotational spectra of several different isotopic species of CH_3HgCl it is shown that $d_{CHg} = 2{\cdot}061 \pm 0{\cdot}02$ Å, $d_{HgCl} = 2{\cdot}282 \pm 0{\cdot}005$ Å, and $\angle CHgCl = 180°$. Similarly, for CH_3HgBr it is shown that $d_{CHg} = 2{\cdot}074 \pm 0{\cdot}015$ Å, $d_{HgBr} = 2{\cdot}406 \pm 0{\cdot}005$ Å, and $\angle CHgBr = 180°$. Nuclear quadrupole couplings evaluated are $Cl^{35} = -42$ Mc/s, $Cl^{37} = -33$ Mc/s in CH_3HgCl, and $Br^{79} = 350$ Mc/s, $Br^{81} = 290$ Mc/s in CH_3HgBr. These indicate ionic character of 62% for the HgCl and 55% for the HgBr bond in these molecules, and lead to a value of 1·7 to 1·8 for the electronegativity of divalent Hg.

A.

539.132 : 535.343–1

Molecular constants of $C^{14}O_2$. *See Abstr.* 3299

539.132 : 535.343.4–1

Molecular constants of sulfur dioxide. *See Abstr.* 3310

539.132 : 535.375.5

Origin of some peculiarities in the Raman spectra of substances with hydrogen bonds. *See Abstr.* 3328

539.132 : 535.375.5

A spectroscopic method of investigating the association of molecules of some organic compounds, in different phase states. *See Abstr.* 3329

539.132

22. The electronic structures and spectra of some olecules related to oxygen. L. E. ORGEL. *J. Chem. c.*, **1953**, 1276–7 (*April*).

The electronic structures and spectra of nitroso- mpounds, nitrites, and azo-compounds are dis- ssed in relation to those of the oxygen molecule. is shown that the diamagnetism of these compounds d their spectra can be interpreted in terms of a mple perturbation treatment of the oxygen molecule. A.

539.132

23. On the application to molecules of the method configuration interaction. R. LEFEBVRE. *C.R. cad. Sci.* [*Paris*] **237**, 1158–60 (*Nov.* 9, 1953) *In rench.*

If self-consistent one-electron wave functions are sed, certain elements of the energy matrix vanish. he application to C_4H_6 shows that doubly excited onfigurations still contribute to the ground state; ne contribution from some becomes, however, egligible, indicating a certain advantage of this choice f orbitals. J. JACOBS

539.132

724. Lifetime of the $^3\Sigma_u^+$ state of nitrogen. E. E. USCHLITZ, JR AND L. GOODMAN. *J. chem. Phys.*, **1**, 2213–17 (*Dec.*, 1953).

A new method is proposed for the measurement of ne "free space" lifetimes of particles in metastable tates. An average lifetime of $2{\cdot}3\times10^{-4}$ sec is btained for nitrogen molecules in the $A^3\Sigma_u^+$ state. he method also gives the collision diameter for ollisions between metastable and normal N_2 mole- ules as 3·8 Å. Measurements of the appearance otential for molecules in the *A* state are presented. A.

539.132

725. The dissociation of H^+_2 by electron impact. . H. KERNER. *Phys. Rev.*, **92**, 1441–7 (*Dec.* 15, .953).

The collision (in Born approximation) of electrons with H_2^+, in which the molecule is raised from the ground state to the lowest lying repulsive state and is herewith dissociated, is discussed as the simplest example of a collision resulting in molecular dissocia- ion. Both the angular distribution of dissociated protons and the excitation of the molecule to a state of definite angular momentum are investigated, and the connection between them is made clear. For the former, rules giving the dominant characteristics of the angular distribution are stated and illustrated by an example; for the latter, a detailed example is given which brings out the scope of the Franck–Condon principle and shows that near the energy of dissocia- tion that gives the Franck–Condon maximum of the scattering amplitude there are also other sizable maxima, i.e. the Franck–Condon principle has a sort of fine structure. A.

539.132 : 535.343

3726. Symmetry classification of the energy levels of some triarylmethyl free radicals and their cations. TING LI CHU AND S. I. WEISSMAN. *J. chem. Phys.*, **22**, 21–5 (*Jan.*, 1954).

The absorption and luminescence spectra of triphenylmethyl, tri-p-xenylmethyl, phenyl-di-p-xenyl- methyl, diphenyl-p-xenylmethyl, and their cations have been determined. Polarization of the luminescence of each substance under excitation by plane polarized light has been examined. Assignment of symmetry classifications to the energy levels of these substances has been attempted. A.

539.132 : 535.343

Electronic spectra of molecules containing six and five membered rings. I. Calculation of energy levels. *See Abstr.* 3293

539.132 : 535.343.4

Analysis and theory of the visible electronic spectrum of the thiophosgene. *See Abstr.* 3307

539.132 : 539.133

3727. The electronic structure and polarity of the water molecule. J. A. POPLE. Letter in *J. chem. Phys.*, **21**, 2234–5 (*Dec.*, 1953).

Theoretical study of the dipole moment due to the lone pair electrons, using symmetry orbitals calculated from the self-consistent molecular orbitals of Ellison and Shull [Abstr. 8625 (1953)]. One symmetry orbital, mainly 2*s*, representing the lone pair, contains enough 2*pz* to have a dipole moment 1·67*D*. This is actually greater than the total calculated moment 1·51*D*, supporting the concept of directed lone pairs. J. HAWGOOD

539.132

3728. Nuclear quadrupole resonance in $B(CH_3)_3$. A. BASSOMPIERRE. *C.R. Acad. Sci.* [*Paris*] **237**, 1224–6 (*Nov.* 16, 1953) *In French.*

Calculation of $\partial_2 V/\partial z^2$ for the sp^2 hybridized orbitals employed gives a value of $1{\cdot}23\times10^{13}$ at the B nucleus of $B(CH_3)_3$. Combined with the observed coupling this gives the B^{11} quadrupole moment as $0{\cdot}05\times10^{-24}$ cm^2. D. H. WHIFFEN

539.132

3729. Nuclear quadrupole resonance of iodine in molecular solids. S. KOJIMA, K. TSUKADA, S. OGAWA AND A. SHIMAUCHI. Letter in *J. chem. Phys.*, **21**, 2237–8 (*Dec.*, 1953).

The coupling constants and asymmetry parameters are given for CH_3I, C_2H_5I, *n*–C_3H_7I, *n*–C_4H_9I, CH_2ICOOH and AsI_3. The high asymmetry, 18·4%, for AsI_3 indicates partial double bond character. D. H. WHIFFEN

539.132

3730. Nuclear quadrupole coupling in the Li_2 molecule. R. M. STERNHEIMER AND H. M. FOLEY. *Phys. Rev.*, **92**, 1460–8 (*Dec.* 15, 1953).

The effect of the quadrupole moment induced in the 1*s* shell on the nuclear quadrupole coupling q in the Li_2 molecule has been investigated for several wave functions. For the most accurate variational wave function of James, the inclusion of the induced moment gives $q/2e = -0{\cdot}00106a_H{}^{-3}$. This result, together with the quadrupole coupling $eqQ = +0{\cdot}060$ Mc/s for Li^7, leads to a negative value of the quadrupole moment $Q(Li^7)$. However, the value of q is so close to zero that the magnitude and even the sign of Q is uncertain. The value of $1/q$ which determines Q is very sensitive to changes in the molecular wave function, and it is shown that a small modifi-

cation of the James wave function would lead to a negative $Q(Li^7)$ which agrees in order of magnitude with the prediction of the nuclear shell model. Calculations of q were also carried out for the Heitler–London and Coulson–Duncanson wave functions for the Li_2 molecule. A.

539.132 : 538.222

3731. A note on the fluorine resonance shifts. A. Saika and C. P. Slichter. *J. chem. Phys.*, **22,** 26–8 (*Jan.*, 1954).

A theoretical analysis is given of the fluorine magnetic resonance shifts in molecules. It is shown that the large range of shifts among different fluorine compounds arises from the effects of binding on the magnetic fields at the nucleus produced by the orbital motion of the electrons in the unfilled valence shell. The simple dependence on ionic character of the bond is also explained. The chemical shift between F_2 and HF is calculated to be 14×10^{-4} compared to the experimentally observed value $6 \cdot 3 \times 10^{-4}$. A.

539.132

3732. On the nature of the bonds in the intermediate complex catalase—$2H_2O_2$. A. Goudot. *C.R. Acad. Sci.* [*Paris*] **237,** 1239–41 (*Nov.* 16, 1953) *In French.*

The intermediate complex passes quickly from a primary ionic state to a covalent one in which the ion is bivalent. In this second state the passage to an activated state occurs due to an electron changing from a bonding to an anti-bonding orbital. In the normal state the system is in a state of resonance corresponding to the two possible configurations of H_2O_2. J. JACOBS

539.132

3733. Electron configuration in 8-coordinated and other complexes. B. Higman. Letter in *J. chem. Phys.*, **21,** 2224–5 (*Dec.*, 1953).

Group-theoretical study of hybridization and bond formation shows that certain results of Kimball (1940) require correction. A dodecahedral arrangement of eight bonds cannot be based on d^4sp^3, one f orbital being needed, sp^4d^2f. The free-atom Hamiltonian is invariant under the orthogonal group; to provide all representations of this group, a fourth (spin) variable, which changes sign under an improper rotation, must be used, as well as x, y, z. Two representations differing only in reversal of sign for improper rotations are equivalent for bond formation. This relaxes some of Kimball's restrictions. J. HAWGOOD

539.132

3734. Unified orbital treatment of ethylene. C. R. Mueller. *J. chem. Phys.*, **22,** 120–2 (*Jan.*, 1954).

Quantum-mechanical calculations of the properties of π- and σ-bonds in ethylene were carried out using atomic, molecular and semilocalized orbital methods. Theoretical values were obtained for binding, and singlet-triplet separation energies. The polarizabilities of these bonds were also calculated, as were the charge distributions. The electronic structure of the π-bond was found to be largely localized contrary to the assumptions of molecular orbital theory, but the σ-bond was found to have molecular orbital structure. On the basis of calculations of bond polarizability it was concluded that π-bond accounts for about 9 of total bond polarizability. This result is due to sp^2 hybridization of the σ-bond. The results extended orbital treatments of π-electron systems also discussed.

539.132 : 54

3735. Theory of the chemical bond. M. Mag *Nuovo Cimento*, **10,** *Suppl. No.* 4, 416–40 (1953) *French.*

A survey (bibliography of 64 refs.) of rece Russian work, divided into three periods: 1947–9 1950–2; 1952–3. Particular attention is paid criticisms of the resonance theory.

539.1

3736. Structure of the monomer of formic ac I. L. Karle and J. Karle. *J. chem. Phys.*, **22,** 43 (*Jan.*, 1954).

This was determined by the sector-microphotome method in electron diffraction. The equilibri distances are C=O = 1·23 ± 0·01 Å, C—O 1·36 ± 0·01 Å, O—O = 2·27 ± 0·005 Å, and an OCO = 122·4° ± 1°. The average displacemen from equilibrium due to the molecular vibrations a listed.

539.133 : 535.343–

3737. On the spectroscopic behaviour of the pol acenes. E. Ruch and H. J. Brüchner. *Z. Natu forsch.*, **8a,** 717–18 (*Nov.*, 1953) *In German.*

The bands of benzene near 37 000 and 47 000 cm are shifted to progressively longer wavelengths moving through the series to naphthalene, anthracer etc. This is explained quantitatively in terms of (1) t disposition of the appropriate electrons and (2) Coulson's treatment [Abstr. 1291 (1951)] of t ring distortion. G. F. LOTHI

539.1

3738. Dimensions of the real chains of line polymers in solutions. M. V. Vol'kenshteĭn an O. B. Ptitsyn. *Dokl. Akad. Nauk SSSR*, **86,** *No.* 493–6 (1952) *In Russian.*

A simple method is proposed for an approxima evaluation of the influence of the volume effects o the dimensions of the polymer molecules. The fin formula shows that, when volume effects are take into account, the value $\sqrt{\bar{h}^2}$ (h being the probab chain length) varies as $N^{0 \cdot 6}$ (not as $N^{0 \cdot 5}$) and that i temperature dependence is less pronounced than wa assumed previously. F. LACHMA

539.13

3739. The proton magnetic resonance in natur rubber. H. S. Gutowsky and L. H. Meyer. *J. chem Phys.*, **21,** 2122–6 (*Dec.*, 1953).

The resonance was observed from liquid nitroge temperature to room temperature. The absorptio line widths show two regions of change. With risin temperature, the first change in width starts at abou 155°K, and is assigned to the onset of CH_3 grou rotation. The second, larger change to a narrow lin starts at about 225°K and is assigned to the onset o segmental motions. The latter change coincides wit the second-order transitions observed in variou physical properties and provides a direct confirmatio of the cause of the transition. Samples cured 30, 6

nd 90 minutes were investigated, and it was found hat curing has a larger effect on the line width hanges at lower temperature than at higher temerature. The inferred greater effect of curing upon CH_3 group motions than upon segmental motions uggests that cross linking is not the primary mechanm of vulcanization. Rubber stretched 70% was found o have the same resonance absorption as unstretched amples. A.

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.15/.18

3740. Experimental nuclear physics. Volume I. Edited by E. SEGRÉ. *London: Chapman and Hall,* x + 789 *pp.*

Review in *Brit. J. appl. Phys.*, **5,** 45 (*Jan.*, 1954). "This first volume comprises five treatises by well-nown authorities: detection methods; passage of adiations through matter; nuclear moments and tatistics; nuclear two-body problems and elements of uclear structure; charged particle dynamics and ptics, relative abundances of the elements, atomic asses. The series is intended for serious students nd for research workers, to enable them to 'catch p' with the progress made in the last few years. he treatment is advanced and mostly presupposes ubstantial acquaintance with nuclear physics; it will uit post-graduate students."

539.15/.18

3741. Experimental nuclear physics. Volume II. Edited by E. SEGRÉ. *London: Chapman and Hall,* 500 *pp.*

Review in *Phil. Mag.*, **45,** 110 (*Jan.*, 1954). "Its ibliography is complete up to the end of 1952 n the two fields with which this volume is concerned, namely (i) a survey of nuclear reactions, and (ii) the eutron."

539.152.1

3742. About similar states of isobaric nuclei. B. S. DZHELEPOV. *Dokl. Akad. Nauk SSSR,* **87,** *No.* 3, 365–8 (1952) *In Russian.*

Energy levels of mirror nuclei are discussed, and it is shown that if the final neutron of the one mirror nucleus and the final proton of the other do not enter into the inner structure, then the energy levels of the latter nucleus are similar in spacing to those of the former, but are displaced by the additional Coulomb energy. The more complicated situation arising when one or both of the final nucleons enter into the inner structure is also discussed. G. E. BROWN

539.152.1

3743. Regularities in the change of binding energy of nucleons in nuclei. V. A. KRAVTSOV. *Dokl. Akad. Nauk SSSR,* **90,** *No.* 5, 749–52 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-*115.

The experimental changes in the binding energy of a proton or neutron associated with the addition of a proton or neutron are plotted against N or Z. The results can be represented (in MeV) by $\sim 20/(N \text{ or } Z)$. W. J. SWIATECKI

539.152.1

3744. The 0^+ -states of the $(4n + 2)$-nuclei. P. STÄHELIN. *Helv. phys. Acta,* **26,** *No.* 6, 691–6 (1953) *In German.*

Low-lying excited states in Li^6, B^{10} and N^{14} with even parity and zero spin (0^+ states) may be ascribed to isotopic spin $T = 1$; nuclear states with the same properties have now been found in Al^{26}, Cl^{34} and K^{38}. This confirms the charge independence of nuclear forces and also shows that the idea of isotopic spin may be used at least up to K^{38}. A. O. STANESBY

539.152.1

3745. The ground state of Cl^{34}. D. C. PEASLEE. Letter in *Nuovo Cimento,* **10,** 1349–50 (*Sept.*, 1953).

The nuclear shell model and knowledge of the $0^+ \rightarrow 0^+\beta^-$ transition to S^{34} are used to assign isotopic spins to the 0^+ ground state ($T = 1$) and the 3^+ excited state ($T = 0$) in Cl^{34}. The nature of the nuclear coupling in these states is discussed.

M. A. GRACE

539.152.1

3746. Possible $0 \rightarrow 0$ (no) β transitions in $4n + 2$ nuclei. O. KOFOED-HANSEN. Letter in *Phys. Rev.*, **92,** 1075 (*Nov.* 15, 1953).

It is pointed out that accurate knowledge of ft values for such transitions would be a valuable check on the charge independence of nuclear forces and would indicate the amount of Fermi interaction in β-decay. P. T. MATTHEWS

539.152.1

3747. An atomic mass study of nuclear shell structure in the region $82 < n < 126$. B. G. HOGG AND H. E. DUCKWORTH. *Canad. J. Phys.*, **32,** 65–71 (*Jan.*, 1954).

A number of new atomic masses are reported in the region $82 < n < 126$ and are used to study nuclear stability in this region. No stability effects associated with a particular neutron number are noticed but rather there is a broad general increase in stability between the 82 and 126 neutron shells. A.

539.152.1

3748. Some regularities in the nuclear level spacings of Hg, Au, and Pt. J. W. MIHELICH AND A. DE-SHALIT. *Phys. Rev.*, **93,** 135–9 (*Jan.* 1, 1954).

An attempt is made to determine any systematic behaviour of nuclear energy levels in a number of heavy elements, as the number of protons (for a fixed neutron number) or neutrons (for a fixed proton number) is changed. Certain regularities in the movement of levels are pointed out and discussed. The occurrence of "pure" $M1$ and mixed $M1 + E2$ transitions (in odd-A nuclei) as related to the type of odd particle and the change in orbital angular momentum is summarized. Empirical evidence for L subshell conversion regularities for $M4$ and $E3$ multipole orders is given. An extension of this work is suggested. A.

539.152.1

3749. Some p- and d-shell nuclei in intermediate coupling. G. E. TAUBER AND T.-Y. WU. *Phys. Rev.*, **93,** 295–301 (*Jan.* 15, 1954).

The theory of intermediate coupling has been applied to nuclei having either two particles or "holes" in the first p or d shell, such as He^6, Li^6, N^{14}, C^{14}, O^{18}, F^{18}, Ca^{38} and A^{38}. A central nucleon-nucleon inter-

action of the form $(mP + nQ)V(r_{12})$, where P denotes the Majorana and Q the Bartlett operator, is assumed and calculations have been carried out for the exponential, Yukawa and Gaussian types of potential $V(r_{12})$ with various "ranges." The coefficients m, n and the constants of the potential $V(r_{12})$ have been estimated from data for two free nucleons. The secular equations have been solved and thus the degeneracy in the energy levels in the two extreme types of couplings has been removed. The energy levels of various spins for the various types of interactions and "ranges" have been plotted against the spin-orbit interaction parameter ζ. The range of ζ giving the correct spin for the ground state is found to depend on the type and "range" of $V(r_{12})$. The magnetic moments for these nuclei can also be obtained with the appropriate wave function for intermediate coupling. It is found that in the case of Li^6, a Yukawa potential having a "range" of about $1{\cdot}0\times10^{-13}$ cm accounts for both known excited states and gives a magnetic moment of $0{\cdot}87\,\mu_N$. For N^{14}, the calculated magnetic moment is $0{\cdot}36\,\mu_N$. A.

539.152.1

3750. On the matrix elements of the spin-orbit interaction in the d^3 configuration. S. Sueoka. *Phys. Rev.*, **93**, 302–3 (*Jan.* 15, 1954).

As a first step in studying the intermediate coupling of the various configurations of d nucleons outside a closed shell, the matrix of the spin-orbit interaction in the d^3 configuration has been calculated, following Jahn's classification of the terms. A.

539.152.1

3751. Nucleon isobars in intermediate coupling. F. H. Harlow and B. A. Jacobsohn. *Phys. Rev.*, **93**, 333–40 (*Jan.* 15, 1954).

The energies of excited states of nucleons are calculated for the symmetric pseudoscalar meson theory with a fixed, extended source. A version of the Tomonaga method, which is shown to be approximately correct in the limit of strong coupling, is used. The calculation is carried out for moderate coupling by using trial functions with 0, 1, 2 and 3 mesons. Numerical results are presented for a source of the Yukawa shape. For coupling stronger than a critical strength which varies with state and source size, isobars are found for angular momenta $\frac{1}{2}$, $\frac{3}{2}$ and for isotopic spins $\frac{1}{2}$, $\frac{3}{2}$. The $(\frac{3}{2}, \frac{3}{2})$ state always lies lowest in energy. A very large source ($\sim\frac{1}{2}$ the meson Compton wavelength) yields a $(\frac{3}{2}, \frac{3}{2})$ isobar at ~350–400 MeV excitation, and a degenerate $(\frac{3}{2}, \frac{1}{2})$ and $(\frac{1}{2}, \frac{3}{2})$ pair at $\geqslant$500 MeV. Other isobars lie considerably higher. Smaller sources correspond to higher excitation energies in this range of coupling strength. A.

539.152.1

3752. Studies in intermediate coupling. II. Radiative transitions in light nuclei. A. M. Lane and L. A. Radicati. *Proc. Phys. Soc.* [*London*] *A*, **67**, 167–80 (*Feb.*, 1954).

For Pt I, see Abstr. 1550 (1954). Formulae are presented for the matrix elements of the various types of radiative transitions of low multipolarity that are frequently met in light nuclei. These formulae are derived on the basis of the nuclear shell-model. Fir of all, extreme *L–S* coupling and extreme *j–j* coupli are considered with a view to seeing if either c give an adequate account of the experimental da It is found, in fact, that neither extreme mode coupling can do this, but that an intermediate coupli probably could. As an example, the radiati transitions in N^{13} are studied in detail in intermedia coupling and are found to give considerable suppo to this contention.

539.152

3753. An explicit formula for the calculation fractional parentage coefficients. P. J. Redmon *Proc. Roy. Soc. A*, **222**, 84–93 (*Feb.* 23, 1954).

A formula is found for a set of particles in equivalc states vector-coupled in the many-body problem wi either *j-j* or *L-S* coupling. The formula is derive without the use of group theory, but in the actu computation it is found convenient to introduce th group theoretical classification. Some examples the application of the formula are given.

539.152.1 : 530.14

Meson-deuteron reaction and nucleon isobars. *Sl Abstr.* 3123

539.152.1 : 539.1

3754. Mu-mesonic atoms and the electromagneti radius of the nucleus. L. N. Cooper and E. M Henley. *Phys. Rev.*, **92**, 801–11 (*Nov.* 1, 1953).

An attempt is made to interpret recent experimen on the X-ray spectrum of μ^--mesonic atoms. particular, an analysis is made of the $2p - 1s$ trans tion energies, which are sensitive to the nuclear charg distribution. Agreement with experiment is obtaine for a uniform sphere of nuclear charge of radiu $R \simeq 1{\cdot}2\times10^{-13}A^{\frac{1}{3}}$ cm. Various effects such a nuclear polarization, electric quadrupole momen screening by atomic electrons, and a meson-nucleo interaction of the order indicated by the charg exchange capture reaction are considered and do n alter this radius appreciably. However, an anomalou meson-nucleus interaction, though doubtful, coul alter the estimated radius. It is shown that the smal nuclear radius is not in disagreement with tha determined by other electromagnetic measurements including mirror nuclei experiments. A

539.152.1 : 539.1

3755. Mu meson as nuclear probe particle. J. A Wheeler. *Phys. Rev.*, **92**, 812–16 (*Nov.* 1, 1953).

The γ-ray ("Chang radiation") given out in th transition of a meson to the $1s$ ground state fro a $2p$ orbit around a heavy nucleus of non-zero quadru pole moment is concluded to consist of severa components of appreciable separation. Measure ments of their energies should give information o (1) nuclear radius, (2) nuclear quadrupole moments (3) the magnetic moment of the meson, (4) the non uniformity of the nuclear charge distribution, an (5) nuclear polarizability and compressibility. A

539.152.

3756. Chlorine quadrupole resonances in solids P. J. Bray and P. J. Ring. Letter in *J. chem. Phys.* **21**, 2226–7 (*Dec.*, 1953).

Frequencies from 32–40 Mc/s were observed wit a self-quenching super-regenerative spectrometer fo

e resonances in halogenated aromatic compounds, nzene sulphonyl chlorides, etc. D. H. WHIFFEN

539.152.2

57. Spin-orbit coupling energy in O^{17}. R. K. DAIR. *Phys. Rev.*, **92**, 1491–3 (*Dec.* 15, 1953).

A proportional counter filled with carbon dioxide as irradiated with monoenergetic fast neutrons oduced by bombarding thin lithium targets with otons from an electrostatic generator. Angular stributions of neutrons scattered by oxygen were educed from the energy spectrum of recoil oxygen ons for neutron energies from 392 keV to 1412 keV, etermining the parities of three spin-$\frac{3}{2}$ levels in O^{17}, ·56, 5·08 and 5·39 MeV above the ground state. he 5·08 MeV state has even parity and appears to e the $D_{\frac{3}{2}}$ member of a $D_{\frac{5}{2}} - D_{\frac{3}{2}}$ doublet, where the $D_{\frac{3}{2}}$ level is then 5 MeV higher than the $D_{\frac{5}{2}}$ ground tate of O^{17}. The other two states have odd parity nd lie more than 1·5 MeV above the lowest spin-$\frac{1}{2}$ dd-parity level. This may indicate a spin-orbit splitting of the order of 2 MeV or greater in the shell. A.

539.152.2

758. The nuclear moments of Se^{79}. W. A. HARDY, G. SILVEY, C. H. TOWNES, B. F. BURKE, M. W. P. STRANDBERG, G. W. PARKER AND V. W. COHEN. *Phys. Rev.*, **92**, 1532–7 (*Dec.* 15, 1953).

Microwave measurements of the $J = 2 \rightarrow 3$ rotational transition of OCSe containing the radioactive nucleus Se^{79} have established the Se^{79} spin as 7/2 and he Se^{79} quadrupole moment as $0{\cdot}7 \times 10^{-24}$ cm^2 ± 0%. The quadrupole coupling constant eqQ is 752·09 ± 0·05 Mc/s. The magnetic moment of Se^{79} has been determined as $-1{\cdot}015 \pm 0{\cdot}015$ nuclear magnetons by observation of the Zeeman splitting of one hyperfine component. The 7/2 spin and the large positive Q are inconsistent with the single-particle nuclear-shell model, but suggest the configuration $g_{9/2})^7_{7/2}$. This assignment is substantiated by the negative magnetic moment. Measurement of isotopic shifts gives a value for the Se^{79} mass, and an odd-even mass difference of 2·4 millimass units for this nucleus. A.

539.152.2

3759. Nuclear magnetic resonance in metals. II. Temperature dependence of the resonance shifts. B. R. MCGARVEY AND H. S. GUTOWSKY. *J. chem. Phys.*, **21**, 2114–19 (*Dec.*, 1953).

For Pt I, see Abstr. 8940 (1952). The temperature dependence of the nuclear resonance shift in metals was investigated in lithium, sodium, rubidium, caesium and gallium. The resonance shifts were found to change by no more than 5 to 6% over temperature ranges of 200°, including the melting point. For sodium, the observed temperature dependence of the resonance shift is correlated directly with the volume dependence predicted theoretically for the mass magnetic susceptibility due to the conduction electrons. In the other metals, effects appear which are related apparently to the volume dependence of the wave functions for electrons at the top of the conduction band. The room temperature resonance shifts of Sn^{117} and Sn^{119} and the temperature dependence of the Rb^{87} line width are also reported for the metals. The resonance shift of tin is $0{\cdot}705 \times 10^{-2}$. The estimation of activation energies for self-diffusion from the temperature dependence of the line widths is discussed. A.

539.152.2

3760. Nuclear moments of U^{233} and U^{235}. K. L. VANDER SLUIS AND J. R. MCNALLY, JR. Letter in *J. Opt. Soc. Amer.*, **44**, 87–8 (*Jan.*, 1954).

Optical h.f.s. measurements show that U^{233} has a nuclear spin 5/2, a nuclear moment of opposite sign to that of U^{235} and a significant quadrupole moment. M. A. GRACE

539.152.2

3761. Experiments on nuclear orientation at very low temperatures. I. Establishment of a method of nuclear alinement and its application to cobalt-60. B. BLEANEY, J. M. DANIELS, M. A. GRACE, H. HALBAN, N. KURTI, F. N. H. ROBINSON AND F. E. SIMON. *Proc. Roy. Soc. A*, **221**, 170–88 (*Jan.* 21, 1954).

Experiments were carried out which demonstrate the possibilities of the method of "magnetic hyperfine-structure alignment" for the orientation of nuclei. Single crystals of composition (1% Co, 12% Cu, 87% Zn) $Rb_2(SO_4)_2$, $6H_2O$ were cooled by adiabatic demagnetization to 0·01°K. The crystals contained a small quantity of radioactive Co^{60}, which decays by β-emission followed by two γ-rays in cascade. The anisotropic distribution of the γ-rays from the oriented Co^{60} nuclei was measured by an array of Geiger counters around the cryostat. The largest anisotropy observed was 33%, and the change in this anisotropy as the crystals warmed up to 1°K was fitted to theoretical curves where the only unknown parameter was the magnetic moment of Co^{60}, for which a value of $3{\cdot}5 \pm 0{\cdot}5$ nuclear magnetons was deduced. A.

539.152.2

3762. The nuclear magnetic moments of K^{41}, Y^{89}, Ag^{107}, and Ag^{109}. E. BRUN, J. OESER, H. H. STAUB AND C. G. TELSCHOW. *Phys. Rev.*, **93**, 172–3 (*Jan.* 1, 1954).

The gyromagnetic ratios of K^{41}, Y^{89}, Ag^{107} and Ag^{109} have been measured by nuclear induction technique. With the known spin values the magnetic moments without diamagnetic corrections are: $\mu_{41} = -0{\cdot}21453 \pm 0{\cdot}00003$ nm, $\mu_{89} = -0{\cdot}136825 \pm 0{\cdot}000004$ nm, $\mu_{107} = -0{\cdot}113014 \pm 0{\cdot}000004$ nm, $\mu_{109} = -0{\cdot}129924 \pm 0{\cdot}000004$ nm. In metallic silver a paramagnetic shift of 0·53% is observed. A.

539.152.2

3763. The magnetic moments of Ag^{107} and Ag^{109} and the hyperfine structure anomaly. P. B. SOGO AND C. D. JEFFRIES. *Phys. Rev.*, **93**, 174–5 (*Jan.* 1, 1954).

The nuclear magnetic moments of Ag^{107} and Ag^{109} are measured by nuclear induction and found to be $\mu(Ag^{107}) = -(0{\cdot}113042 \pm 0{\cdot}000013$ nm and $\mu(Ag^{109}) = (0{\cdot}129955 \pm 0{\cdot}000013)$ nm. The ratio of the moment is measured to be $\mu(Ag^{107})/\mu(Ag^{109}) = 0{\cdot}86985 \pm 0{\cdot}00001$; this ratio combined with the ratio of the h.f.s. separations as measured by Wessel and Lew yields for the h.f.s. anomaly $\Delta = -(0{\cdot}412 \pm 0{\cdot}006)\%$, which is compared to calculated values. A.

539.152.2

3764. The nuclear magnetic moment of S^{35} by microwave spectroscopy. B. F. Burke, M. W. P. Strandberg, V. W. Cohen and W. S. Koski. *Phys. Rev.*, **93**, 193–4 (*Jan.* 1, 1954).

The nuclear magnetic moment of S^{35} has been measured by the Zeeman effect in the microwave spectrum of OCS yielding a value of $1{\cdot}00 \pm 0{\cdot}04$ nm. A value of the electric quadrupole coupling constant in OCS is found to be $21{\cdot}90 \pm 0{\cdot}04$ Mc/s. A.

539.152.2

3765. The tendency for positive nuclear quadrupole moments. S. A. Moszkowski and C. H. Townes. *Phys. Rev.*, **93**, 306–12 (*Jan.* 15, 1954).

An examination of the signs of nuclear quadrupole moments and of the nuclear states which produce them affords fairly striking evidence that a positive quadrupole moment tends to lower the energy of a nuclear state. For nuclei containing several particles outside of closed shells the shell model often does not uniquely specify the sign of the quadrupole moment. The ground states of such nuclei are, however, known to have positive quadrupole moments in the great majority of cases. Additional evidence for this tendency is provided by a discussion of: (*a*) The ground states of Cu, Ga, As, Br and Rb. (*b*) The exceptions to the single-particle version of the shell model, Na^{23}, Mn^{55}, Se^{79}, Eu^{153} and Yb^{173}. (*c*) The spins of ground states of odd-odd $N = Z$ nuclei. The favouring of positive quadrupole moments appears to be accounted for by electrostatic and other known forces in conjunction with large core deformations. It may, perhaps, also be influenced by tensor forces. A.

539.152.2 : 535.338.332

Magnetic moment of Zr^{91}. *See Abstr.* 3285

539.152.2 : 538.222

Theory and measurement of relaxation times in nuclear paramagnetic resonance. *See Abstr.* 3668

539.152.2 : 539.132

3766. Nuclear spins and band spectra of the selenium isotopes. S. P. Davis. *Phys. Rev.*, **93**, 159–62 (*Jan.* 1, 1954).

An investigation of the rotational structure of the $^1\Sigma_u^+ - {}^1\Sigma_g^+$ band system of Se_2 in the region 3700–3815 Å, using separated isotopes of selenium, has made possible the assignment of $I = \frac{1}{2}$ to the nucleus Se^{77}, and the confirmation of $I = 0$ for Se^{78} and Se^{80}. At the same time a number of new facts regarding the predissociation and the rotational constants of the Se_2 molecules are established. A.

539.153

3767. Geometrical determination of the *K*, *L*, *M*, shells of the atoms and ions Be, F^-, Al^{+3}, Ca^{+2}, Rb^+, Hg. S. Odiot. *C.R. Acad. Sci.* [*Paris*] **237**, 1399–401 (*Nov.* 30, 1953); Erratum **238**, 531 (*Jan.* 25, 1954) *In French.*

The shell radii were calculated by assuming them to be defined by the minima in the electron radial distribution functions. Hartree's self-consistent field-wave functions, without exchange, were used.

J. HUGHES

539.1

3768. Electric field gradients of atomic *p* electro
R. G. Barnes and W. V. Smith. *Phys. Rev.*, **93**, 95
(*Jan.* 1, 1954).

Calculations from optical spectra data of t
electrostatic field gradient existing at the position
the nucleus in atoms depend on the effective atom
number Z_i. The present article presents a survey
Z_i values obtained for various elements in varyi
degrees of ionization. One may conclude from th
survey that the relation $Z_i = Z - n$ is a good appro
mation for calculations dealing with *p* electrons. C
the basis of this relation the average $\langle 1/r^3 \rangle$ has be
evaluated for low-lying states of interest in chemic
bonding for atoms having *p* valence electrons. T
results are presented in a graphical form from whi
the values for the more complicated cases of N, P,
and Sb are obtained by interpolation. Atomic fie
gradients obtained are compared with previous es
mates in a number of cases of interest.

539.153 : 530.1

3769. Level calculations in μ-mesic atoms. S. W
Flügge and F. T. Adler. Note in *Naturw*
senschaften, **40**, *No.* 23, 601–2 (1953).

With the potential from the extended nucle
charge distribution represented as an oscillat
potential, energies of the 1*S*, 2*S* and 2*P* levels a
calculated. Level splittings due to the spin of th
μ-meson and a possible magnetic moment a
discussed. G. E. BROW

539.153

3770. Correlation energies and angular componen of the wave functions of the ground states of H He I, and Li II. L. C. Green, M. N. Lewis, M. M
Mulder, C. W. Wyeth and J. W. Woll, Jr. *Phy*
Rev., **93**, 273–9 (*Jan.* 15, 1954).

With a view to examining the effects of configuratio
interaction in the ground state of the three simp
atomic systems, H^-, He I and Li II, a three-paramet
variational function involving a symmetrized expo
nential in the nuclear distances and a linear facto
in the interelectron distance has been obtained fo
He I and Li II. These functions together with the or
of the same type already in existence for H^- have bee
expanded in series of Legendre functions of th
cosine of the angle between the two radius vector
The coefficients in these expansions are functions o
the nuclear distances of the two electrons. Th
various component functions are presented, togethe
with the coefficients with which they enter the expan
sions, and their contributions to the total energie
A discussion is given of the method of estimating th
magnitude of the total correlation, or configuratio
interaction, energy and its radial, angular and mixe
parts. A table is given of the values of the correlatio
energy and its various parts for H^-, He I and Li II. A

539.154.3 : 548.736.

3771. Magnetic moments and crystal structure o ferromagnetic metals and alloys. F. Gal'perin
Dokl. Akad. Nauk SSSR, **88**, *No.* 4, 643–6 (1953) *Russian.* English translation, *U.S. National Sc*
Found. NSF-tr-68.

Demonstrates that the formula proposed by th
author [Abstr. 6022 (1950)] for the calculation o

gnetic moments of ferromagnetic metals and ys can be satisfactorily applied to ferrites and logous compounds, without separating ferrites a special class [Abstr. 3388 (1948)]. F. LACHMAN

539.155.2

2. A method of changing the isotope abundance nercury. E. HAEFFNER. Letter in *Nature* [*London*] , 775–6 (*Oct.* 24, 1953).

Describes experiments conducted in order to nge the isotope composition of Hg by passing . through it. It has been found in two experiments t the light isotopes are enriched at the anode and heavier isotopes at the cathode when the current passed through Hg in a narrow cell fitted with a phragm. F. LACHMAN

539.155.2 : 542.48

73. On the enrichment of heavy water by fractional tillation. W. EHRENBERG AND H. JAFFKE. *Z. gew. Phys.*, **5**, *No.* 10, 375–6 (1953) *In German.*

539.155.4 : 548.73

74. A determination of the Avogadro number. BROGREN. *Ark. Fys.*, **7**, *Paper* 4, 47–55 (1953).

X-ray diffraction measurements were used to give it cell volumes of several crystals. The mol. wts. re calculated from atomic wts. of isotopes and eir relative abundances. Calcite and quartz gave e best determinations: $N = 6{\cdot}02500 \times 10^{23}$ on the ysical scale of atomic wts., and $e = 4{\cdot}8027 \times 10^{-10}$ e.s.u. (probable errors not stated). Diamond d rocksalt, KCl and LiF were also investigated but re less satisfactory. A. R. STOKES

ADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.08

775. Measurement of the β-activity of thick urces. P. LERCH. *Helv. phys. Acta*, **26**, *No.* 6, 53–90 (1953) *In French.*

The variation of self-absorption of the β-radiation P^{32} in thick sources was studied as a function of eometry, back-scattering, ratio of the detector/source eas, the presence of screens between source and etector, and the density and chemical nature of the ource. The absolute β-activity of thick sources can en be determined within an error of $\sim$ 5–8%. A. O. STANESBY

539.16.08 : 621.374.32 : 621.387.4

776. Some recently developed instruments for radio-ctivity measurements. I. NILSSON. *Trans Instrum. Meas. Conf.*, **1952**, 135–8.

The instruments described are (1) a Ge diode incidence circuit for Geiger counters—resolving me ~ 3 μsec—and (2) a counting-rate computer, iving a continuous record of counting rates in the ange 500–50 000 counts/min. J. J. WILKINS

539.16.08 : 778.34

777. On an arrangement for recording the particles mitted by radioelements: ciné-nucleography. M. RILLEY. *C.R. Acad. Sci.* [*Paris*] **237**, 1326–7 *Nov.* 23, 1953) *In French.*

An apparatus is described which will move a radioactive source rapidly over the surface of a nuclear emulsion. This will enable short-period radioactivity to be investigated by the method of ciné-nucleography described by Laporte [Abstr. 2693 (1954)]. A. C. COATES

539.162

3778. Average charge of recoil atoms from several nuclear transitions. S. WEXLER. *Phys. Rev.*, **93**, 182–7 (*Jan.* 1, 1954).

The average charge of daughter atoms following nuclear transformation has been measured for several active species. The positive ion current of the decay products was observed in the gas of the parent at low pressure and compared with the disintegration rate of the active nuclide. The average positive charges found in the several transitions studied vary from <1 (T_2, β^- decay) to 10 ± 2 ($C_2H_5Br^{80m}$, isomeric transition, γ, e^-). A.

539.163 : 548

3779. Crystal structure and nuclear directional correlation. I. Pb^{204}. H. FRAUENFELDER, J. S. LAWSON, JR, W. JENTSCHKE AND G. DEPASQUALI. Letter in *Phys. Rev.*, **92**, 513 (*Oct.* 15, 1953).

The directional correlation of Pb^{204} (65 min isomer) has been measured, using both solid and liquid Pb–Tl mixtures as sources. The observed crystal structure effects are greater than expected theoretically. J. J. WILKINS

539.163

3780. Disintegration of Ca^{47}, Sc^{47}, Va^{48}, and Rh^{100}. L. MARQUEZ. *Phys. Rev.*, **92**, 1511–16 (*Dec.* 15, 1953).

The disintegration of four radioactive isotopes was investigated, with the following results: Ca^{47} decays by the emission of two β-ray groups with end-point energies and relative intensities of 685 keV, 81%; and 2060 keV, 19%. Sc^{47} decays by the emission of two β-ray groups of end-point energies and relative intensities of 280 keV, 28%; and 490 keV, 72%. V^{48} decays by the emission of one single positron groups with end-point energy of 693 keV. Rh^{100} decays by the emission of five positron groups with end-point energies and relative intensities of 150 keV, 0·06%; 540 keV, 3·64%; 1260 keV, 12·8%; 2070 keV, 38·5%; and 2615 keV, 45·0%. Procedures for preparation and chemical purification of these nuclides are described; and also their other characteristics such as half-lives, conversion electrons of associated γ-rays, etc. A.

539.163.1

3781. Half-life determination of Po^{210} by alpha counting. M. L. CURTIS. *Phys. Rev.*, **92**, 1489 (*Dec.* 15, 1953).

A half-life of 138·374 ± 0·032 days was determined by counting a sample of approximately 0·5 millicurie over a period of 328 days. A.

539.163.1

3782. The half-life of Am^{243}. H. DIAMOND, P. R. FIELDS, J. MECH, M. G. INGHRAM AND D. C. HESS. *Phys. Rev.*, **92**, 1490–1 (*Dec.* 15, 1953).

The α half-life of Am^{243} was found to be 8800 ± 600 years. The ratio of Am^{243} and Am^{241} masses in the sample was measured with a mass spectrometer, and the ratio of their α activities was measured with a

differential α-pulse analyser. A method for preparation of thin samples of americium by electrodeposition is described. A.

539.163.2

3783. Experimental evidence that Y^{90} is not a pure beta-emitter. B. Makiej. *Bull. Acad. Polon. Sci. Cl.* 3, **1**, *No.* 3–4, 127–30 (1953).

Absorption in lead of weak γ-radiation from Y^{90} showed a soft component due to internal bremsstrahlung, and a hard component attributed to a single 1·5 MeV γ-ray ($\sim 5\times10^{-4}$/disintegration): this decayed with the half life of Y^{90}. M. A. GRACE

539.163.2

3784. Formation and radiations of germanium 67. A. H. W. Aten, Jr, T. de Vries-Hamerling and L. Lindner. Letter in *Physica*, **19**, 1046 (*Oct.*, 1953).

Irradiation of Zn with 52 MeV He ions yielded Ge with 19 min $\frac{1}{2}$-life, decaying by β^+ emission (E_{max} = 3·4 ± 0·3 MeV) and a 0·17 ± 0·01 MeV γ-ray. M. A. GRACE

539.163.2

3785. The short-lived neutron-deficient isotope of selenium. F. N. Hooge and A. H. W. Aten, Jr. Letter in *Physica*, **19**, 1047–8 (*Oct.*, 1953).

44 min Se prepared by irradiating Ge with 52 MeV He ions was found to decay by β^+ emission of maximum energy 1·7 ± 0·2 MeV. Mass assignment is discussed. M. A. GRACE

539.163.2

3786. The decay of calcium 47. A. H. W. Aten, Jr, E. Greuell and W. J. van Dijk. Letter in *Physica*, **19**, 1049–50 (*Oct.*, 1953).

Absorption measurements showed β-spectra with end-points at 2·0 ± 0·2 and 0·8 ± 0·2 MeV (relative intensities 1 : 3·4 ± 1). A 1·3 ± 0·2 MeV γ-ray was observed on a scintillation spectrometer. M. A. GRACE

539.163.2

3787. The decay of vanadium 47 and manganese 51. A. H. W. Aten, Jr, J. Kooi, B. de Vries and A. L. Veenedaal. Letter in *Physica*, **19**, 1051–2 (*Oct.*, 1953).

No γ-radiation (<20%) from these isotopes was found. M. A. GRACE

539.163.2

3788. On the [nuclear level] scheme of As^{73}. R. Barloutaud, R. Ballini and M. Sartori. *C.R. Acad. Sci.* [*Paris*] **237**, 886–8 (*Oct.* 19, 1953) *In French.*

An alternative level scheme for As^{73} is discussed, with reference to recent measurements of conversion coefficients and of $X_K - X_K$ coincidences. A. O. STANESBY

539.163.2

3789. On the disintegration of RaB. S. Kageyama. *J. Phys. Soc. Japan*, **8**, 689–96 (*Nov.–Dec.*, 1953).

The disintegration of RaB was studied by a β-ray spectrometer, with coincidence counter techniques. The β-ray spectrum of RaB obtained was complex, consisting of two components with end point energies 590 ± 10 and 650 ± 10 keV. This result was also confirmed by coincidence measurements between the internal conversion electrons of the 242, 295 and 350 keV γ-rays of RaC and the β-rays of RaB, u a pair of 180° focusing spectrometers. The rela intensities of the two β-ray groups obtained, 5 was in accord with the excitation probabilities g by Ellis, and also with the transition probabil calculated from the γ-ray intensities obtained Muller *et al.* Judging from these experimental res the level scheme proposed by Ellis seems to be m plausible than that of Stern.

539.1

3790. A study of the radiations emitted by N. Marty, H. Langevin and P. Hubert. *J. P Radium*, **14**, 663–71 (*Dec.*, 1953) *In French.*

Using a magnetic lens spectrometer and scintilla counters, β^--components of E_{max} 1·255 ± 0·01 0·87 ± 0·02 MeV and a β^+-spectrum of E_{max} 1·2 0·05 MeV were observed, as well as 2 γ-rays of and 670 keV, and Te X-radiation. A consis disintegration scheme, including spins and parities put forward; the ground state of I^{126} is 1^+. A. O. STANE

539.1

3791. Decay of Ga^{66}. L. G. Mann, W. Meyerhof and H. I. West, Jr. *Phys. Rev.*, 1481–9 (*Dec.* 15, 1953).

Scintillation equipment consisting of a three-cry pair spectrometer, two-crystal Compton spectrome and single NaI(Tl) and anthracene crystals used coincidence were used to investigate the decay of G γ-rays of 4·83 (2), 4·33 (4·5), 4·12 (1·5), 3·78 3·41 (3), 3·24 (2), 2·75 (22), 2·40 (2), 2·18 1·93 (3·5), 1·58 (<0·4), 1·37 (3), 1·04 (30), a 0·83 (1) MeV energy were observed. (Intensit given parentheses, indicate per cent of Ga^{66} deca These are fitted into a consistent decay scheme which Ga^{66} decays to levels in Zn^{66} at 4·83 4·33 (8), 4·12 (1·5), 3·78 (21), 3·41 (4), 3·24 2·75 (2), 2·40 (~0·5), 1·04 (<0·5) and 0 (56) M (Branching intensities, given in parentheses, indic percentages.) The β- and γ-ray branchings have b used to assign possible spins and parities to the st involved.

539.16

3792. On the radiations emitted during the tra mutation RAc → AcX. I. M. Frilley, S. Rosenblu M. Valadarès and G. Bouissières. *J. Phys. Radiu* **15**, 45–9 (*Jan.*, 1954) *In French.*

Precise measurements of the conversion spectr of a very pure RAc source are reported, covering region of γ-ray energies <100 keV. The results discussed together with existing data on the α, and conversion spectra, and a satisfactory interpre tion is obtained. J. J. WILK

539.16

3793. Coincidence studies of the decay of indium 1 M. W. Johns, C. C. McMullen, R. J. Donnel and S. V. Nablo. *Canad. J. Phys.*, **32**, 35–48 (*Ja* 1954).

A coincidence circuit of resolving time 3×10^{-9} has been used to examine the decay of In^{114}. Coin dence experiments are described to show that of t 5 γ-rays which follow the *K*-capture process t 0·722 and 1·300 MeV radiations are both in casca

the 0·556 MeV γ-ray and that the spins and ties of the excited levels of energy 0·556, 1·278 1·856 MeV in Cd^{114} are 2+, 2+ and 0+, ectively. The observed β-γ coincidences may be ibed to a combination of inner bremsstrahlung ciated with the strong 2 MeV β^- transition and a k β^- group of intensity less than 1×10^{-3} β per integration and end point about 0·8 MeV. The itron spectrum has a branching ratio of $4 \pm 1\times$ $^{-5}$ and an end point between 1·0 and 1·4 MeV. A.

539.163.2

4. Nuclear spectroscopy of neutron-deficient Hg opes. L. P. GILLON, K. GOPALAKRISHNAN, A. SHALIT AND J. W. MIHELICH. *Phys. Rev.*, **93**, –35 (*Jan.* 1, 1954).

n order to extend knowledge of nuclear level tematics in the Pt–Au–Hg region, neutron-deficient topes of Hg were produced by high-energy proton nbardment of Au. A technique is described for the lysis of the very complex internal conversion elec- n spectra present in the decay chains of Hg topes produced by Au(p, xn)Hg reactions where = 1 to 8 or 9. More or less complete decay chains m Hg to Pt or Ir are postulated for masses 195 to) or 189. A.

539.163.2

95. Radioactivity of Sm^{153} and Eu^{155}. M. R. LEE D R. KATZ. *Phys. Rev.*, **93**, 155–9 (*Jan.* 1, 1954).

The radiations from Sm^{153} and Eu^{155} have been ndied by means of a 180°, magnetic-focusing, riable-field β-ray spectrometer-spectrograph using riched materials. In the disintegration of 47·0 hr ^{153}, conversion electrons of 3 γ-rays of energy 0691, 0·1027, 0·548 MeV, and 3 β-ray spectra ose end-point energy and relative intensity were 255 MeV, 9%; 0·685 MeV, 70%; 0·795 MeV, 21%, pectively, were observed. A fourth β-ray spectrum end-point energy 0·62 MeV and intensity less than % is postulated. A decay scheme in good agreement th these data and with nuclear shell theory is oposed in which spin and parity have been assigned all levels. The discrepancy between the magnetic oment measurement and the requirements of shell eory as to the parity of the ground-state of Eu^{153} s been resolved in favour of shell theory. In the sintegration of Eu^{155} 2 β-ray spectra of end-point ergy 0·152 and 0·252 MeV and relative intensity % and 16%, respectively, and conversion electrons 4 γ-rays of energy 0·0593, 0·0858, 0·1045, 1309 MeV were observed, in agreement with earlier ork. Weak conversion-electron lines attributed to rays of energy 0·0187 and 0·1368 MeV were also served. A.

539.163.2

96. A new neutron-deficient isotope of krypton. . A. CARETTO, JR AND E. O. WIIG. *Phys. Rev.*, **93**, 5–6 (*Jan.* 1, 1954).

A new neutron-deficient isotope of krypton, Kr^{76}, ith a half-life of $9·7 \pm 0·5$ hr has been produced the spallation of yttrium. Its genetic relationship ith its 17·2 hr Br^{76} daughter was established by olation experiments. Kr^{76} decays by weak positron nission (probably >0·6 MeV). A search for electron pture by this nuclide gave negative results. A.

539.163.2

3797. A new 3·0-min Ce fission product and its 5·95-hr Pr daughter. S. S. MARKOWITZ, W. BERNSTEIN AND S. KATCOFF. *Phys. Rev.*, **93**, 178–80 (*Jan.* 1, 1954).

Rapid chemical separations of Ce from neutron-irradiated U led to identification of a 3·0 min Ce which decays to 5·95 hr Pr. The former emits β-rays, whose maximum energy is approximately 2·0 MeV, and γ-rays whose spectrum was not investigated. The Pr decays by emission of a single β-ray whose maximum energy is 1·7 MeV; no γ-rays were found. This chain has tentatively been assigned to mass 145. A.

539.163.2

3798. Disintegration of Au^{198}. L. G. ELLIOTT, M. A. PRESTON AND J. L. WOLFSON. *Canad. J. Phys.*, **32**, 153–66 (*Feb.*, 1954).

In addition to the 411·77 keV γ-ray transition, two γ-ray transitions of energies $676·5 \pm 0·8$ keV and $1088·9 \pm 0·9$ keV have been observed in Hg^{198} following the disintegration of Au^{198}. The intensities of these transitions were found to be $(8·20 \pm 0·56)\times 10^{-3}$ and $(1·63 \pm 0·12)\times10^{-3}$ per disintegration respectively. The K conversion coefficient of the 676·5 keV transition was measured as $0·0224 \pm 0·0019$, identifying the radiation as a mixture of magnetic dipole and electric quadrupole. The K conversion coefficient of the 1088·9 keV transition was measured as $0·00450 \pm 0·00034$, identifying this radiation as electric quadrupole. A β-transition to the ground state of Hg^{198}, of energy 1371 keV and intensity $(2·5 \pm 0·5)\times10^{-4}$ per disintegration, has been observed and identified as a third-order forbidden transition. The shape of this spectrum has been studied above the end point of the intense 959 keV β-transition. Of the four combinations considered for the β-decay interaction form, viz. *SA*, *VA*, *ST*, *VT*, it was found that the experimental shape can be fitted by any one of *VA*, *ST* or *VT*, but not by *SA*. The $\log f_0 t$ value for the transition is 11·7. A disintegration scheme is proposed in which the excited states of Hg^{198} at 412 and 1089 keV are each assigned spin 2 and even parity and the ground state of Au^{198} spin 3 and odd parity. A.

539.163.2 : 539.152.1

3799. Search for the $p_{\frac{1}{2}}$ isomeric state in Tc^{101} and identification of energy-levels. D. R. WILES. *Phys. Rev.*, **93**, 181–2 (*Jan.* 1, 1954).

Careful half-life measurements by various methods give $14·6 \pm 0·1$ min for Mo^{101} and $14·3 \pm 0·1$ min for Tc^{101}. Measurements of the β- and γ-energies give substantially the same values as previous workers report. Spin and parity assignments have been made to all levels observed. A search was made for the possible existence of isomeric $p_{\frac{1}{2}}$ Tc^{101m}, with no evidence for measurable half-life. The evidence is that this state lies above the 7/2+ state, and decays to it by an $E3$ transition with short half-life rather than by $M4$ transition to the $g_{9/2}$ state. A.

539.164

3800. Alpha activity of Sm^{146} as detected with nuclear emulsions. D. C. DUNLAVEY AND G. T. SEABORG. Letter in *Phys. Rev.*, **92**, 206 (*Oct.* 1, 1953).

The Sm^{146} was formed from the bombardment of neodymium with 40 MeV α-particles. From the track lengths in the emulsion, the α-particle energy

was $2{\cdot}55 \pm 0{\cdot}05$ MeV. From a determination of the amounts of the isotopes Sm^{153} and Sm^{145} also formed in the α-particle bombardment, an estimate of the amount of Sm^{146} was made. Correlating this with the emission rate of the 2·55 MeV α-particles gave $\sim 5 \times 10^7$ years for the half-life of Sm^{146}.

J. HUGHES

539.164

3801. Complex alpha spectra of radiothorium (Th^{228}) and thorium-X (Ra^{224}). F. ASARO, F. STEPHENS, JR AND I. PERLMAN. *Phys. Rev.*, **92**, 1495–500 (*Dec.* 15, 1953).

The α- and γ-spectra of Th^{228} were studied with an α-particle spectrograph and γ-ray scintillation counters. Thorium 228 has α-groups of 5·421 (71%), $5{\cdot}338_5$ (28%), 5·208 (0·4%) and 5·173 MeV (0·2%), and γ-rays of 89 (1·6%), 137 (0·26%), 169 (0·09%), and 212 keV (0·27%). Spins and parities are assigned to the energy levels defined by the α-groups, and the results are evaluated with respect to the developing theory and systematics of complex α-spectra. A.

539.164.74 : 539.185 : 537.534.74 : 537.533.74

Inelastic collisions and the Molière theory of multiple scattering. *See Abstr.* 3547

539.164.92 : 537.564

The ionization in air maintained by a uniform plane circular distribution of α radioactivity. *See Abstr.* 3617

539.165

3802. Beta activity of In^{109}. S. N. GHOSHAL. Letter in *Curr. Sci.*, **22**, 296–8 (*Oct.*, 1953).

The radiations emitted by thin Ag foils after bombardment with 21 and 37 MeV α-particles were observed using a magnetic lens β-spectrometer; 2 positron groups of $E_{max} \sim 0{\cdot}9$ and 2·2 MeV are ascribed to In^{109} from the $(\alpha, 2n)$ reaction with Ag^{107}.

A. O. STANESBY

539.165

3803. Research on an inverse β-radioactivity. T. GRJEBINE AND H. LAURENT. *C.R. Acad. Sci.* [*Paris*] **237**, 1226–8 (*Nov.* 16, 1953) *In French.*

An attempt was made to detect any possible intermediate particle emitted in β^--decay by its nuclear absorption. Ethyl iodide was irradiated in a pile and free I_2 formed by the Szilard–Chalmers reaction deposited on silver; any absorption of the radiation of I^{128} by Ag^{108} might have led to the formation of Pd^{109} (13 hr). No Pd^{109} activity could be found, and an upper limit of 8 Pd^{109} nuclei produced per sec by 1 c of I^{128} decaying completely on silver is set.

A. O. STANESBY

539.165

3804. The second-forbidden beta-spectra of Co^{60} and Sc^{46}. G. L. KEISTER AND F. H. SCHMIDT. *Phys. Rev.*, **93**, 140–5 (*Jan.* 1, 1954).

A hitherto unreported high-energy β-ray component has been found in the decay of Co^{60}. Its abundance and end-point are $(0{\cdot}15 \pm 0{\cdot}01)\%$ and $1{\cdot}48 \pm 0{\cdot}02$ MeV, respectively. The abundance and end-point of the Sc^{46} high-energy component are $(0{\cdot}096 \pm 0{\cdot}01)\%$ and $1{\cdot}25 \pm 0{\cdot}02$ MeV, respectively. Both the Co^{60} and Sc^{46} spectra can be fitted with the C_{2T} correction factor corresponding to $\Delta J = 2$ and no parity change. The log *ft* values, uncorrected for forbidden shape, are: $Co^{60} = 12{\cdot}6$ and $Sc^{46} = 1$ The decay schemes are discussed.

539.165 : 531

Accuracy limitations of β-ray thickness measurem *See Abstr.* 3153

539.165 : 539.1

3805. Contribution by chemical element to fiss product beta activity. F. J. KENESHEA, JR AND A. SAUL. *Nucleonics*, **11**, 26–30 (*Nov.*, 1953).

Calculations of Thornton and Houghton have extended to obtain the relative contribution of of the principle elements formed in fission to gross β-activity. Curves are plotted showing t contributions as a function of cooling time for irradiation times of 1, 5, 30 and 60 days. The elem considered include all those which occur in ch having fission yields greater than 0·8%, except Br and Sb. L. R. SHEPH

539.1

3806. Principles of beta-decay theory. D. WILES. *Nucleonics*, **11**, 32–5 (*Nov.*, 1953).

β-decay theory is outlined briefly. Method evaluating $f(Z, E_0)$ are discussed and graphs ai the evaluation are given. The use of compara lifetimes in the assignment of states of energy leve illustrated by reference to the decay of Zn^{69}.

L. R. SHEPH

539.1

3807. Upper limits on the neutrino mass from tritium beta spectrum. D. R. HAMILTON, W. ALFORD AND L. GROSS. *Phys. Rev.*, **92**, 152 (*Dec.* 15, 1953).

The shape of the tritium β-spectrum near the point was investigated in a spherical electrost integral spectrograph with particular reference to possible effects of a non-zero neutrino mass. I shown that the source thickness of 100 micrograms/ may be satisfactorily taken into account in the kilovolt of the spectrum, upon which the results based. An upper limit to the neutrino mass of 250 and 150 eV is found for the Dirac, Majorana Fermi forms, respectively, of the β-interaction.

539.1

3808. On the electron-neutrino angular correlati M. MORITA. *Progr. theor. Phys.*, **9**, 345–58 (*A* 1953).

The electron-neutrino angular correlation functi are calculated for the allowed and first-forbid transitions in the Fermi theory of β-decay taking i account the effect of the nuclear charge. The in ferences which arise due to squaring of terms in interaction work out perfectly. The Major theory is also handled for the allowed transiti The differences observed between both theories not serious. The experimental data of P^{32} are c sistent with the tensor interaction.

539.1

3809. Electron-neutrino angular correlation fu tions in the theory of beta decay. G. N. FOWL *Proc. Phys. Soc.* [*London*] *A*, **67**, 117–24 (*Feb.*, 19

The angular correlation functions have b calculated for linear combinations of interacti

uding combinations of scalar and vector inter-
ons or of tensor and axial vector interactions) in
first and second forbidden approximations with
ect of the Coulomb field corrections. A.

539.165.2 : 539.152.1

). Isotopically invariant theory of beta decay. V. Sudakov. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 6, -10 (1953) *In Russian.* English translation, *U.S. ional Sci. Found. NSF-tr*-130.

he electron, positron and neutrino are considered different states of the same system, the precise e being determined by the components of an opic spin vector. An interaction Hamiltonian is ned with this vector, spinor operators, the nucleon opic spin vector and nucleon fields. The demand this Hamiltonian be "isotopically invariant," is, invariant with respect to rotations in the bined isotopic spin space, rules out the scalar, doscalar and pseudovector variants of the usual ecay schemes, while permitting the vector and or variants. G. E. BROWN

539.166

1. Installation and operation of ten-kilocurie alt-60 gamma-radiation source. J. V. Nehemias, E. Brownell, W. W. Meinke and E. W. Coleman. *er. J. Phys.*, **22**, 88–92 (*Feb.*, 1954).

he expanding interest in studies of the effects of adiation upon biological and chemical systems has ouraged the production of increasingly higher el sources for various institutions. Recently, at University of Michigan, a ten-kilocurie cobalt-60 adiation source has been installed and is now in tine operation. A brief discussion of some of problems involved in installation and operation of h a source and some of the studies being under- en is presented. A.

539.166

2. γ-Radiation of Sb^{124}. K. Gromov, B. helepov, N. Zhukovskiĭ, A. Silant'ev and Yu. ol'nov. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 2, -8 (1952) *In Russian.*

Using a Compton electron γ-spectrometer 8 lines e found at 597, 711, 958, 1052, 1347, 1691, 0 keV with rel. intensities 1·54, 0·19, 0·066, 0·044, 7, 1·00, 0·10. A level scheme can be constructed Te^{124} consistent both with the β^--spectrum of ^{24} and the β^+-spectrum of I^{124} (Kern, *et al.*, 1948). W. J. SWIATECKI

539.166

3. γ-Radiation from the reaction $^{27}Al(p, \gamma)^{28}Si$. G. Rutherglen, P. J. Grant, F. C. Flack and M. Deuchars. *Proc. Phys. Soc.* [*London*] *A*, **67**, -10; Erratum 197 (*Feb.*, 1954).

The spectra of γ-radiation at the resonances for ton capture in Al^{27} occurring at $E_p = 404$, 503,), 652 and 677 keV were studied with a sodium lide scintillation spectrometer. The angular distri- tions of the more prominent γ-ray components re determined at each resonance. Spin and parity ignments to levels in Si^{28} are made on the basis of se and other measurements. A.

539.166.08 : 771.53

γ-Ray sensitivity curve of photographic emulsions. *Abstr.* 2993

539.166.2

3814. Directional correlation of two successive radiations emitted by oriented nuclei. J. A. M. Cox and H. A. Tolhoek. *Physica*, **19**, 1178–86 (*Dec.*, 1953).

The correlation probability $W(\mathbf{k}_1, \mathbf{k}_2, \boldsymbol{\eta})$ for the directions $\mathbf{k}_1$ and $\mathbf{k}_2$ of two radiations emitted in cascade by an ensemble of oriented nuclei is calculated. The unit vector $\boldsymbol{\eta}$ is an axis of rotational symmetry along which the nuclei are oriented. The result is specialized to the case of γ-γ correlations. For two dipole transitions $j \to j-1 \to j-2$ and for two quadrupole transitions $j \to j-2 \to j-4$ explicit formulae are given, which are suitable for direct evaluation. A.

539.166.2

3815. Gamma-gamma angular correlation in Pd^{106}. E. D. Klema and F. K. McGowan. *Phys. Rev.*, **92**, 1469–72 (*Dec.* 15, 1953).

The angular correlation of the 624 and 513 keV γ-rays and that of the 1045 and 513 keV γ-rays of Pd^{106} were measured with a coincidence scintillation spectrometer using NaI detectors. For a dilute ruthenium chloride aqueous solution source, the correlation function of the 624–513 keV cascade is

$$W(\theta) = 1 + (0{\cdot}3456 \pm 0{\cdot}0079)P_2(\cos\theta) + (1{\cdot}109 \pm 0{\cdot}012)P_4(\cos\theta);$$

that of the 1045–513 keV cascade is

$$W(\theta) = 1 + (0{\cdot}0921 \pm 0{\cdot}0027)P_2(\cos\theta) + (0{\cdot}0350 \pm 0{\cdot}0092)P_4(\cos\theta).$$

In each of the above functions, the finite angular resolution of the equipment has been taken into account. The measurement on the 1045–513 keV cascade establishes the spin of the 1550 keV level as two and gives the intensity of the electric quadrupole radiation as 4·24 ± 0·14% relative to the intensity of the magnetic dipole radiation in the 1045 keV transition. A.

539.166.2

3816. Energy levels of Ti^{48} from the decay of Sc^{48} and V^{48}. H. Casson, L. S. Goodman and V. E. Krohn. *Phys. Rev.*, **92**, 1517–21 (*Dec.* 15, 1953).

The γ-rays following the decay of Sc^{48} and V^{48} were investigated by means of threefold coincidence techniques. In the case of Sc^{48}, it was found that within the limits of experimental error all of the decays occur via a three-γ cascade. In V^{48}, although the decay occurs primarily via a two-γ process, a small three-γ contribution was detected. By twofold coincidence measurements, the 2·2 MeV γ-ray of V^{48} decay was found to be in cascade with the 0·99 MeV γ-ray. Level schemes are proposed for both decays. A.

539.166.83

3817. The Auger electrons of radium E. T. Novakow. Letter in *Bull. sci. Cons. Acad. Yugoslavie*, **1**, 11–12 (*Jan.*, 1953) *In French.*

It is suggested that the electron spectrum of RaE might be Auger electrons resulting from internal conversion of inner bremsstrahlung. Using a high-resolution β-spectrometer, lines were found at 75, 80 and 86 keV, with relative intensities 2 : 0·8 : 1. The same lines are also associated, as expected, with the transition ThC → ThC′. A. O. STANESBY

539.166.83

3818. Measure of *K*-shell internal conversion coefficients with a coincidence scintillation spectrometer. F. K. McGowan. *Phys. Rev.*, **93**, 163–72 (*Jan.* 1, 1954).

The *K*-shell internal conversion coefficients of γ-rays from Te^{123}, Sm^{153}, Hf^{181}, and Os^{191} have been measured using a coincidence scintillation spectrometer employing NaI and anthracene phosphors as detectors. In several cases an unambiguous classification of the transition as to multipole order and character is possible. The results indicate that the 159 keV γ-ray from Te^{123} is predominantly $M1$, the 70 keV γ-ray from Sm^{153} is a mixture of $E2 + M1$, the 132 keV γ-ray from Hf^{181} is predominantly $E2$, the 135 keV γ-ray from Hf^{181} is predominantly $M1$, the 345 keV and 480 keV γ-rays from Hf^{181} are a mixture of either $E2 + M1$ or $E1 + M2$, and the 129 keV γ-ray from Os^{191} is a mixture of either $E2 + M1$ or $E1 + M2$. A.

539.166.83

3819. A cloud chamber study of internal pairs from $^{12}C^*$. G. Harries. *Proc. Phys. Soc.* [*London*] *A*, **67**, 153–7 (*Feb.*, 1954).

The nature and multipolarity of the 4·45 MeV γ-ray from carbon-12* are obtained from the angular distribution of the positrons and electrons of internal conversion pairs photographed in a cloud chamber. The transition is found to be of electric quadrupole origin. Accordingly, a spin of 2^+ is ascribed to the first excited level in C^{12} and a decay scheme is proposed for C^{12*} at the lower energies. A transformation formula is given which relates the spatial angular distribution of cloud-track pairs to the distribution of pair-angles projected on to a plane of reference. A.

539.166.832

3820. On the transition curves of various materials for the X-rays of a 31 MeV betatron. G. Breitling and R. Glocker. *Z. Naturforsch.*, **8a**, 629–32 (*Oct.*, 1953) *In German.*

The curves were obtained with an integrating crystal counter. In Zn and Pb a secondary maximum was found, corresponding to the mean range of pairs particles. An approximate rule is given, correlating the relative heights of the maxima with their position through the rate of production of Compton electrons and of pairs, which is in agreement with experiments except for heavy elements. L. Pincherle

539.166.835

3821. A note on the angular distribution of pair-electrons of 17 MeV γ-rays. S. Shimizu and J. Muto. *Mem. Coll. Sci. Univ. Kyoto A*, **25**, 61–2 (*Oct.*, 1949).

Angular distributions with respect to the incident γ-rays were measured for 36 pairs emitted from a Pb plate in a cloud chamber. The results are consistent with theory. J. J. Wilkins

539.166.835

3822. An analysis of the electron pairs produced in nuclear emulsions by cosmic rays photons. G. Baroni, A. Borsellino, L. Scarsi and G. Vanderhaeghe. *Nuovo Cimento*, **10**, 1653–61 (*Dec.*, 1953).

A comparison has been made between the theory of electron pair production by photons and experimental data, for energies up to 400 MeV. The following points have been analysed: (1) Energy part... between the two members of the pair; (2) Statis... distribution of the momentum transfer to the ... (3) Distribution of the angle of divergence of the ...

539.16...

3823. Emission of electron-positron pairs from ... nuclei. I. Monopole transition in ^{16}O. S. Dev... G. Goldring and G. R. Lindsey. *Proc. Phys.* [*London*] *A*, **67**, 134–47 (*Feb.*, 1954).

An apparatus is described for measuring ... angular correlation of electron-positron pairs f... light nuclei. It has been used to study the ... emitted in the monopole transition from the ... excited state of O^{16}. Measurements are also ... scribed of the excitation function for this state of... in the reaction $F^{19}(p, \alpha)O^{16}$, and of the absc... probability (half-life) of the monopole transition.

539.1...

3824. Production of I^{131} for medical use ... tellurium irradiated in the uranium pile at Kje... K. Taugbøl and U. Blix. *JENER Rep., No.* ... 6 *pp.* (1953).

Very pure Te is ground and irradiated for ... 2 weeks in sealed Al cans. The apparatus use... the chemical separation of I^{131} is illustrated ... described, and the process of separation discusse... detail. F. Lach...

539.1...

3825. Exchange reactions and Szilard–Chalm... effect in cobalt- and copper-hexacyanocobaltic (... W. Buser and U. Imobersteg. *Experientia*, **9**, *No...* 288–9 (1953) *In German.*

Exchange experiments with labelled

$$Co^{II}[Co^{II}Co^{III}(CN)_6]_2$$

(each Co atom was made radioactive in turn) indic... that Co is bound in 3 different ways. The excha... of Co^{III} in the complex was negligible. The ... statistically occupying the holes in the main cu... lattice exchanges quickly and completely, while ... remaining Co^{II} participates slowly in excha... reactions. Due to the Szilard–Chalmers effect ... accumulated in the holes of the main cubic lattice ... $Cu^{II}[Cu^{II}Co^{III}(CN)_6]_2$ irradiated by neutrons. ... Co^{60} was removed from the interior of the s... compound by exchange with Cu^{2+} and separa... electrolytically. The enrichment was $> 10^6$ ... $\sim$60% of the Co^{60} could be extracted. T. A. Chalm...

539.1...

3826. The use of radioactive tracers in the field ... dielectrics. A. Gemant. *Arch. elekt. Übertragu...* **7**, 386–9 (*Aug.*, 1953) *In German.*

Survey of uses of radioactive tracers for (1) de... mining the chemical nature, molecular radii and ... dispersion of ions in liquid dielectrics [see A. Gem... *J. phys. Chem.*, **54**, 569, 1950] and (2) leak location... buried cables [see A. Gemant *et al.*, Abstr. 4628 (19... and Abstr. 2682 (1953)]. J. H. Ma...

539.1...

3827. Recommendations for the disposal of carbon... wastes. *Handb. Nat. Bur. Stand., No.* 53, 14 ... (1953).

The report sets out recommendations for the val...

sotopic dilution, and concentration of C^{14} in the posal of waste material by incineration, burial, as bage, by discharge into sewers, or in waste gases harged into the atmosphere. L. R. SHEPHERD

539.169 : 578.088.5

8. Radio elements used as tracers in biology. MORIN. *Cahiers de Phys., No.* 46, 34–43 (*Nov.*, 3) *In French.*

Discusses in brief the general aspects, and also in ail an investigation using a synthetic oestrogen, romotriphenylethylene labelled with Br^{82}, injected o a female mouse. D. V. MABBS

NUCLEAR REACTIONS 539.17

539.172

29. A rotating thin ice target. G. R. BISHOP, PRESTON AND J. M. WESTHEAD. *J. sci. Instrum.*, , 64–6 (*Feb.*, 1954).

Construction and operation are described. Targets easily variable thickness can be made and main- ned under bombardment by intense ion beams. A.

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 34–40

539.172

30. Excitation of the nucleus by the absorption of mesons. II. Results and conclusions. V. DE BBATA, E. MANARESI AND G. PUPPI. *Nuovo Cimento*, , 1704–28 (*Dec.*, 1953) *In Italian.*

For Pt I, see Abstr. 7908 (1953). The problem is eated by the Monte Carlo method and results are mpared with experience. The distribution of stars gainst the number of visible prongs, the percentage fast protons ($E > 30$ MeV), the emission ratio particles protons, the percentage of captures without sible prongs agree with experimental data if it is pposed that the primary act of absorption in matter performed by a proton-neutron pair. Remembering e results of the capture by nuclei of π-mesons in ght it might be concluded that the capturé of -mesons in nuclear matter at all energies (at least o to 100 MeV) is essentially due to a proton-neutron air. A.

539.172.11

331. The reaction $^{13}C(\alpha n)^{16}O$. G. A. JONES AND . H. WILKINSON: Note in *Proc. Phys. Soc.* [*London*] , **66**, 1176–9 (*Dec.*, 1953).

The excitation function of this reaction was deter- ined in the range 1 to 2 MeV using an NaI crystal detect neutrons emitted at 0° to the α-particle beam om a thin target of natural carbon. Well-defined esonances were observed at energies corresponding states of O^{17} at $7{\cdot}158 \pm 0{\cdot}009$ and $7{\cdot}372 \pm 0{\cdot}011$ MeV. The lower resonance appeared to have width of about 3 keV and it is suggested that eutrons of high angular momentum, namely $l = 4$ r more are involved. L. R. SHEPHERD

539.172.13 : 539.152.1

832. Energy levels of Be^8. R. MALM AND D. R. NGLIS. Letter in *Phys. Rev.*, **92**, 1326 (*Dec.* 1, 1953).

Alpha-particle groups from the $B^{11}(p,\alpha)Be^8$ reaction (with resonance protons, $E_p = 1{\cdot}98$ or $2{\cdot}61$ MeV) were observed in a 16 in. 2-dimensional focusing magnetic spectrometer at 90°, using a proportional counter for detection. The range of excitation energy E_{ex} of Be^8 from 0–7 MeV was investigated, and only the sharp ground state and broad $2{\cdot}9$ MeV state peaks appeared; groups with peak height $\gtrsim 0{\cdot}1$ of the ground-state groups would have been observed. A. O. STANESBY

539.172.13

3833. Nuclear configurations inferred from high-energy pickup-deuteron distributions. W. SELOVE. Letter in *Phys. Rev.*, **92**, 1328 (*Dec.* 1, 1953).

Graphs are given of the deuteron energy distributions from targets of C/Si/Al/ bombarded with protons with energy 95 MeV. In carbon, the presence of a sharp energy peak is interpreted as evidence for the α-particle structure of the nucleus, and an analysis of the angular distribution indicates a Gaussian distribution for the picked-up deuteron. All light nuclei of the type $4n$ show evidence of this α-particle structure. J. HUGHES

539.172.13

3834. A search for B^{13}. E. L. HUBBARD, L. RUBY AND W. F. STUBBINS. *Phys. Rev.*, **92**, 1494 (*Dec.* 15, 1953).

When various elements were bombarded with 340 MeV protons and 190 MeV deuterons, no neutron activity was found which would correspond to the decay of B^{13} as a delayed neutron emitter with a half-life in the range from $0{\cdot}5$ msec to $0{\cdot}5$ hr. A.

539.172.13

3835. On a possible variant of the Bethe–Weizsäcker cycle. J. M. GILLES. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 2, 196–204 (1953) *In French.*

The variant is to replace the two reactions $N^{14} + p \rightarrow O^{15}$, $O^{15} \rightarrow N^{15} + \beta^+$ by the new reactions $N^{14} + \beta^- \rightarrow C^{14}$, $C^{14} + p \rightarrow N^{15}$. The electron-capture cross-section is calculated, and it is shown that the original cycle is much faster than the modified one, except in circumstances where the $p(p,d)\beta^+$ reaction is more important than either. J. M. CASSELS

539.172.13

3836. Cross sections for formation of Na^{22} from aluminium and magnesium bombarded with protons. R. E. BATZEL AND G. H. COLEMAN: *Phys. Rev.*, **93**, 280–2 (*Jan.* 15, 1954).

Cross-sections were determined for the energy range from thresholds to 32 MeV. The $Al^{27}(p,p\alpha n)Na^{22}$ reaction has a threshold of 25 MeV and the cross-section for the reaction rises to a value of $2{\cdot}5$ millibarns at 32 MeV. The cross-section for the production of Na^{22} from magnesium has a value of $0{\cdot}25$ millibarn at 10 MeV, rises through a maximum of 9 millibarns at 17 MeV, drops to a minimum of 5 millibarns at 23 MeV and then rises to a value of 19 millibarns at 32 MeV. A.

539.172.13

3837. Excitation functions of proton-induced reactions of Nb^{93}. R. A. JAMES. *Phys. Rev.*, **93**, 288–90 (*Jan.* 15, 1954).

The excitation functions for the (p,n), (p,pn) and $(p,\alpha n)$ reactions of Nb^{93} were determined with proton

energies up to 21 MeV. A new niobium activity with half-life of 13 ± 2 hr was found and has been assigned to an isomeric state of Nb^{92}. This new activity decays by electron capture and emits a 2·35 MeV γ-ray. Recent results by other workers on the characteristics of the 10-day Nb^{92} were verified. A.

539.172.13

3838. Absorption cross sections for 134 MeV protons. J. M. CASSELS AND J. D. LAWSON. *Proc. Phys. Soc.* [*London*] *A*, **67**, 125–33 (*Feb.*, 1954).

The cross-sections of carbon, aluminium, copper, cadmium and lead were measured by a transmission method. The results are consistent with the predictions of the usual optical theory for high energy nuclear cross-sections. A.

539.172.13

3839. Nuclear disintegrations caused by 50–125 MeV protons. II. P. E. HODGSON. *Phil. Mag.*, **45**, 190–201 (*Feb.*, 1954).

For Pt 1, see Abstr. 8680 (1953). A method of separating nuclear disintegrations caused in photographic emulsion by 50–125 MeV protons into those in the light and those in the heavy nuclei of the emulsion is described. It is used to determine the characteristics of the disintegrations of the light and the heavy nuclei. These results show that about 30% of the low energy particles emitted from nuclear disintegrations are the result of a nuclear cascade initiated by the primary particle. A.

539.172.13

3840. (d,p) and (d,n) reactions. J. HOROWITZ AND A. M. L. MESSIAH. *J. Phys. Radium.*, **14**, 695–706 (*Dec.*, 1953) *In French.*

The validity of Butler's theory [Abstr. 8973 (1951)] of stripping is examined, by considering the equivalent (p,d) and (n,d) reactions. Butler's theory ignores the interference of the various outgoing waves, the most important of which is that describing the elastic scattering of the incoming nucleon. The general theory is reformulated to include this effect. Numerical calculations are made for the S and P waves in various special cases, assuming that the elastic scattering is purely "potential." In most cases the angular distribution is not appreciably different from the Butler theory, but the total cross-sections are reduced by a factor of from two to five.

P. T. MATTHEWS

539.172.13

3841. The mechanism of stripping reactions. J. HOROWITZ AND A. M. L. MESSIAH. Letter in *Phys. Rev.*, **92**, 1326–7 (*Dec.* 1, 1953).

A more detailed publication by the same authors (preceding abstract) is summarized. In addition it is found that the stripped particle is partially polarized for $l > 0$, and that in $(d,p\gamma)$ reactions the actual shape of the distribution is completely different from that of the Butler theory, though the overall anisotropy remains. P. T. MATTHEWS

539.172.13

3842. The theory of the deuteron stripping reactions. N. C. FRANCIS AND K. M. WATSON. *Phys. Rev.*, **93**, 313–17 (*Jan.* 15, 1954).

The deuteron stripping reactions are analysed from the point of view of the many-body problem. A rigorous formal solution is given. From this it is shown how assumptions less restricted than Butler can be employed to reduce the many-body interactions to those of a deutron moving in a potential w At this point, the relation to previous theories readily established. The present theory might termed "the optical model" of the stripping reactio and represents a considerable generalization of curr theories.

539.172.13 : 539.15

3843. The energy levels of Be^{10}. K. B. RHOD AND J. N. MCGRUER. Letter in *Phys. Rev.*, 1328–9 (*Dec.* 1, 1953).

The proton spectrum from the reaction $Be^9(d,p)Be$ with 14·5 MeV incident deuterons, was observ with a magnetic spectrometer. In addition to two known levels at 3·37 and 7·37 MeV, two n levels at 5·94 and 6·24 MeV were found. J. HUGH

539.172

3844. Energies and angular distributions of neutro from $Be^9(d,n)B^{10}$. J. S. PRUITT, C. D. SWARTZ A S. S. HANNA. *Phys. Rev.*, **92**, 1456–60 (*Dec.* 15, 195

The angular distributions of neutrons fr $Be^9(d,n)B^{10}$, leading to the five lowest states of B were measured at a bombarding energy E_d 0·945 MeV. These distributions are compared w previous data for $Be^9(d,p)Be^{10}$. In both cases there evidence for the deuteron stripping process. Int pretation of the distributions is discussed. Excitati energies are obtained for the B^{10} states.

539.172

3845. Scattering of deuterons in helium. LAURITSEN, T. HUUS AND S. G. NILSSON. *Ph Rev.*, **92**, 1501–6 (*Dec.* 15, 1953).

The scattering of deuterons in helium gas w investigated at three angles in the energy ran 1000 to 1200 keV. A pronounced resonance appea at $E_d = 1069$ keV, of width 35 keV (lab), whi corresponds to the 2·187 MeV level of Li^6. It established that the level in question has $J = 3$, ev parity, and a reduced width of the order of the sing particle limit. The best fit to the observations obtained with a channel radius of $4{\cdot}0\times10^{-13}$ c taking into account the effect of the ground sta $J = 1^+$, which is assumed to have the same reduc width. A brief search, carried out at only one ang revealed no further levels below $E_d = 2{\cdot}0$ MeV.

539.172

3846. Nuclear reaction determination of the Sn^{124} Te^{124} mass difference. N. S. WALL. *Phys. Rev.*, 9 1526 (*Dec.* 15, 1953).

The Q values for the ground state (d,p) reactio on Sn^{124} and Te^{124} were measured and found to $Q_0 = 3{\cdot}52 \pm 0{\cdot}07$ MeV and $Q_0 = 4{\cdot}25 \pm 0{\cdot}07$ Me respectively. From these data and the decay energi of Sn^{125} and Sb^{125} the mass difference of $Sn^{124} - Te$ is found to be $2{\cdot}4 \pm 0{\cdot}1$ MeV.

539.172

3847. Angular distributions and excitation curv for the $B^{10}(d,p)B^{11}$ and the $B^{10}(d,n)$ and $B^{11}(d,$ reactions below 2-MeV bombarding energy. W. H BURKE, J. R. RISSER AND G. C. PHILLIPS. *Phys. Re* **93**, 188–92 (*Jan.* 1, 1954).

Protons from the $B^{10}(d,p)B^{11}$ reaction and neutro

om the $B^{10}(d,n)$ and $B^{11}(d,n)$ reactions were counted r deuteron bombarding energies below 2 MeV. ngular distributions were measured at several ombarding energies. The angular distributions iggest that the stripping process plays an important art in the reaction. As might then be expected, no arrow resonances were observed in the excitation nctions. A.

539.172.13

3848. Angular distribution of protons from the reaction $Na^{23}(d,p)Na^{24}$. P. SHAPIRO. *Phys. Rev.*, **93**, 90–4 (*Jan.* 15, 1954).

The angular distribution of several of the proton roups from the $Na^{23}(d,p)Na^{24}$ reaction was studied sing 3 MeV deuterons. The results were compared vith the Butler theory of the angular distributions rom (d,p) reactions. A value of $l_n = 2$ is assigned o the orbital angular momentum of the neutron aptured in the formation of the ground state of Na^{24} rom Na^{23}. Since the available evidence indicates hat the parity of the ground state of Na^{24} is even, a value of $l_n = 2$ implies that the ground state of Na^{23} also has even parity. The two proton groups resulting when Na^{24} is produced in the 0·472 MeV and 0·564 MeV excited states could not be resolved. The angular distribution of the sum of these two groups could not be uniquely interpreted. The author favours the interpretation that one of these levels is formed by capture of a neutron with $l_n = 0$ and the other by capture of a neutron with $l_n = 2$. Then both levels would have even parity, the possible spin values being 1 or 2 for one of the levels and 1, 2, 3 or 4 for the other level. The data on the 1·341 MeV level in Na^{24} indicate that it is formed by capture of a neutron with $l_n = 0$. Hence this level has even parity and a spin of either 1 or 2. A.

539.172.13

3849. Nuclear reactions with energetic nitrogen ions. H. L. REYNOLDS, D. W. SCOTT AND A. ZUCKER. *Proc. Nat. Acad. Sci.* [*U.S.A.*] **39**, 975–85 (*Aug.*, 1953).

Survey experiments on the bombardment of D, Be, B, C, N, O and S with 25 MeV N^{+++} are described. A table of the thick-target yields relative to $C^{12}(N^{14})Na^{24}2H^1$ is given for the different possible reactions identified by the $\frac{1}{2}$-lives of the products. M. A. GRACE

539.172.13

3850. Nuclear reactions produced by nitrogen and oxygen ions. K. F. CHACKETT, J. H. FREMLIN AND D. WALKER. *Phil. Mag.*, **45**, 173–89 (*Feb.*, 1954).

In the production of radioactive isotopes by bombardments with N^{14} ions accelerated in the Birmingham sixty-inch cyclotron, total initial activities of some hundreds of thousands of counts per minute have been produced in aluminium targets. The following radioactive nuclei, in order of yield, have been identified with certainty among the products: P^{32}, Al^{28}, Cl^{34}, K^{38}, P^{30}, S^{35}, Si^{31}, Na^{24}. In addition to these isotopes, Mg^{27}, N^{13} and C^{11} have been detected with certainty; the evidence for F^{18}, Cl^{38} and Na^{22} is inconclusive. Bombardment of aluminium with O^{16} ions was shown to give K^{38}, Cl^{34}, P^{30}, F^{18}, P^{32} and Na^{24}. Most of the assignments of activity have been confirmed chemically. The experimental observations are not easily explained if the colliding nuclei simply fuse into a compound nucleus which then undergoes evaporation or fission; it is suggested that usually only part of one nucleus sticks to the other. A.

539.172.3

3851. On the fission threshold energies of heavy nuclei. O. MIYATAKE AND T. YASAKI. *J. Inst. Polytech. Osaka City Univ. B*, **2**, 23–5 (*Oct.*, 1951).

The liquid drop nuclear model with a stable core of 50 neutrons and 28 protons is used to account for the experimental values for photofission threshold. M. A. GRACE

539.172.3

3852. High-energy (γ, d) reactions. J. W. DEWIRE, A. SILVERMAN AND B. WOLFE. Letter in *Phys. Rev.*, **92**, 519 (*Oct.* 15, 1953).

C, Cu, and Pb targets have been bombarded with 310 MeV bremsstrahlung, and the relative yields of deuterons and protons at 90° have been measured, using a two-crystal telescope. J. J. WILKINS

539.172.3

3853. Elastic photoproduction of π^0's from deuterium. J. W. DEWIRE, A. SILVERMAN AND B. WOLFE. Letter in *Phys. Rev.*, **92**, 520 (*Oct.* 15, 1953).

The cross-section has been measured for 250–300 MeV incident γ-rays and π^0 mesons emitted at 90°–120° angles. The result indicates opposite couplings of the neutron and proton to the π^0 ($g_p = -g_n$). J. J. WILKINS

539.172.3

3854. Study of photodisintegrations using photographic emulsions: experimental arrangements and preliminary measurements. I. R. CHASTEL. *J. Phys. Radium*, **14**, 707–16 (*Dec.*, 1953) *In French.*

The preliminary calibrations concerning the production of γ-rays by the reaction ${}_4Li^7 + {}_1H^1 \rightarrow {}_4Be^8 + \gamma$ are described in detail; including measuring the γ-ray intensity as a function of the proton energy by an ionization chamber and by the photo-activation of ${}_{29}Cu^{63}$, and determining the angular and energy distributions of the γ-rays. The conditions are specified for the irradiation of nuclear emulsions and for processing and viewing them after irradiation. A. C. COATES

539.172.3

3855. Photoneutron cross sections of some elements. J. GOLDEMBERG AND L. KATZ. *Canad. J. Phys.*, **32**, 49–59 (*Jan.*, 1954).

The neutron yield from photo-reactions in 9 elements has been measured as a function of the maximum energy of the University of Saskatchewan betatron. Cross-sections are given for each of the reactions as calculated from these data. The integrated cross-sections are compared with theoretical sum-rule predictions of Levinger and Bethe and good agreement is obtained with $x = \frac{1}{2}$. The data support the conclusions reached in a preceding paper by Montalbetti, Katz, and Goldemberg [Abstr. 7930 (1953)]. The competition between (γ, n) and (γ, p)

reactions in chromium and in nickel is analysed in the light of these experimental results. Good agreement with statistical theory is obtained in both cases. A.

539.172.3

3856. Precision determination of photoneutron thresholds. M. BIRNBAUM. *Phys. Rev.*, **93,** 146–54 (*Jan.* 1, 1954).

The photoneutron thresholds for C^{12}, N^{14}, O^{16}, CU^{63}, and Ag^{109} were determined by measurement of the yield of activity as a function of the peak bremsstrahlung energy. Measurements of the photoneutron thresholds of C^{12}, N^{14}, and O^{16}, which could be calculated accurately from the mass data, served to determine the energy scale. The photoneutron thresholds for Cu^{63} and Ag^{109} were found to be $10{\cdot}61 \pm 0{\cdot}05$ MeV and $9{\cdot}07 \pm 0{\cdot}07$ MeV, respectively. The shape of the activation curves for C^{12}, N^{14}, and O^{16} appeared to be a straight line for about 350 keV near threshold. The activation curves for Cu^{63} and Ag^{109} could be fitted accurately by functions of the form $Y = k(E - E_t)^{2.23}$ and $Y = k(E - E_t)^{1.90}$, respectively, over a 3 MeV interval. E refers to the peak X-ray energy and E_t to the threshold energy. A.

539.172.4

3857. Relative cross-sections of (n, p) reactions in sulphur 32 and phosphorus 31. N. K. SAHA AND M. CHOUDHURY. *Indian J. Phys.*, **27,** 244–50 (*May*, 1953).

Fast neutrons from a 100 milligram (Raα + Be) source were used to produce (n, p) reactions in S^{32} and P^{31}. The radioactive end products of the reactions, P^{32} ($T \sim 14{\cdot}2$ days) in the case of S^{32}, and Si^{31} ($T \sim 170$ min) in the case of P^{31}, serve as indicators of the reactions. By the principle of "threshold detector," the initial radioactivity of the end product in each case is a measure of the average cross-section of the (n, p) reaction over a narrow band of neutron-energy between the threshold of the reaction and the upper limit of the effective neutron-energy for capture. The saturation conditions of irradiation and measurement are found by elaborate preliminary experiments. The initial activity, measured in this way by a G.M. counter under fixed geometry, comes out to be 367 counts per 2 min for S^{32} and 240 counts/2 min for P^{31}. Various corrections for chemical or isotopic composition of the sample, self-absorption of β-rays, non-saturation of activity, etc., are applied. The ratio of relative cross-sections of (n, p) reaction for S^{32} to P^{31} is finally obtained as ~ 2 with a probable error of about $\pm 10\%$. This agrees reasonably well with the ratio $\sim 2{\cdot}37$ obtained by Cohen with much higher energy of fast neutrons. Importance of work on these lines for the interpretation of high energy excitation states of nuclei is discussed. A.

539.172.4

3858. Inelastic neutron scattering in Al, Fe, Mg, and Cu. R. E. GARRETT, F. L. HEREFORD AND B. W. SLOOPE. *Phys. Rev.*, **92,** 1507–8 (*Dec.* 15, 1953).

γ-Rays emitted from nuclei excited by inelastic neutron scattering were observed. Pulse-height analysis of γ-ray scintillations which were coincident with scattered neutrons established γ-lines corresponding to excited levels in the residual nuclei. Observed levels are reported for Al, Fe, Mg, and Cu.

539.172

3859. Slow neutron resonances in tantalum. R. CHRISTENSEN. *Phys. Rev.*, **92,** 1509–10 (*Dec.* 1, 1953).

A crystal spectrometer has been used to investigate the total neutron cross-section in tantalum in the region 0·3 to 50 eV. Resonances were detected at 4·29, 10·36, 13·9, 20·7, 24·2, 36·7, and 39·4 eV. The strengths of these resonances vary by a factor of about 35; this condition is attributed to a large variation in neutron width. The level spacing in this odd even monoisotopic element has been estimated as 6 eV.

539.172

3860. Neutron absorption and scattering by hafnium. L. M. BOLLINGER, S. P. HARRIS, C. T. HIBDON AND C. O. MUEHLHAUSE. *Phys. Rev.*, **92,** 1527–31 (*Dec.* 1, 1953).

Thermal activation, thermal absorption, resonance scattering, resonance transmission, and multiplicity of capture γ-rays were measured for the stable isotopes of halnium. Isotopic assignments of the various resonance levels are presented which are consistent with all the data observed. Where possible, the level spacing is estimated. A.

539.172.

3861. Neutron inelastic scattering. R. M. KIEHN AND C. GOODMAN. *Phys. Rev.*, **93,** 177–8 (*Jan.* 1, 1954).

The neutron inelastic scattering of iron has been studied as a function of neutron energy from the threshold at 850 keV to 2·0 MeV. The yield of 850 keV γ-rays emitted by de-excitation of the first excited state has been measured by means of a NaI scintillation spectrometer. Similar work is in progress on Al, Pb, Bi, and other elements. A.

539.172.4

3862. Thermal neutron resonance of Sm. A. W. MCREYNOLDS AND E. ANDERSEN. *Phys. Rev.*, **93,** 195–6 (*Jan* 1, 1954).

The total neutron cross-section of Sm has been measured over the energy range 0·005 to 0·18 eV using a crystal spectrometer. Agreement with a Breit–Wigner one-level resonance formula is very good except that higher cross-sections below 0·04 eV suggest an additional lower energy resonance. A.

539.172.4 : 539.152.1

3863. Inelastic scattering of neutrons by In^{115} and Au^{197}. A. A. EBEL AND C. GOODMAN. *Phys. Rev.*, **93,** 197–8 (*Jan.* 1, 1954).

The metastable states In^{115m} and Au^{197m} have been produced by bombarding indium and gold foils with neutrons (energy spread ± 20 to 40 keV). The excitation curve for gold has a threshold at $0{\cdot}53 \pm 0{\cdot}02$ MeV and shows distinct discontinuities in slope at $1{\cdot}14 \pm 0{\cdot}03$ MeV and $1{\cdot}44 \pm 0{\cdot}03$ MeV corresponding to energy levels that decay to the metastable state at 0·54 MeV. The excitation curve for indium has a threshold below 600 MeV and indicates levels at $0{\cdot}960 \pm 0{\cdot}04$ MeV and $1{\cdot}37 \pm 0{\cdot}04$ MeV. Cross-

ction values cannot be deduced because of adequate calibration of the scintillation detector. A.

539.172.4 : 539.152.1

3864. Cross sections for production of In^{115m} and Au^{197m} by inelastic scattering of neutrons. H. C. Martin, B. C. Diven and R. F. Taschek. *Phys. Rev.*, **93**, 199–204 (*Jan.* 1, 1954).

Cross-sections for the reactions $In^{115}(n, n')In^{115m}$ and $Au^{197}(n, n')Au^{197m}$ have been measured from the reaction thresholds to 5·5 MeV. The lowest mean energy for which the In^{115m} excitation was observed was 440 keV with an energy spread of ±100 keV; the cross-section rises to a peak value of 0·36 barn at 1·5 MeV. The lowest mean energy for which the Au^{197m} excitation was observed was 420 keV with an energy spread of ±40 keV; the cross-section rises to a peak value of 1·3 barns at 2·5 MeV. Both cross-sections show irregularities which are evidence of energy levels in the target nuclei. A.

539.172.4 : 539.152.1

3865. Inelastic scattering of neutrons near threshold. B. Margolis. *Phys. Rev.*, **93**, 204–7 (*Jan.* 1, 1954).

Using the compound nucleus model, and assuming a statistical distribution of levels of the compound state, the inelastic neutron scattering cross-sections for excitation of metastable states of Cd^{111} and In^{115} are calculated. The energy range just above threshold is considered. The sensitivity of the cross-sections to the spin and parity of the metastable state is demonstrated in the case of Cd^{111}. Comparison is made with experiment, and the calculations are seen to be useful in learning about spins and parities of excited states of nuclei. A.

539.172.4

3866. On the scavenger effect in the *n*, γ reaction in carbon tetrachloride. W. H. Hamill and R. R. Williams, Jr. *J. chem. Phys.*, **22**, 53–6 (*Jan.*, 1954).

Neutron bombardment of liquid CCl_4 yields 38·5 min Cl^{38}, and approximately 40% of the induced activity is retained in organic form. Dissolved chlorine reduces this retention in a regular fashion to approximately 25% at a concentration of 6 mole %. Allyl chloride increases retention to 53% in equivalent concentrations. Neither of these "scavenger effects" is significantly dependent on the intensity of total dose of concomitant nonactivating pile radiation. This rules out the radiation-decomposition theory of scavenger action and supports an atom-radical diffusion-recombination mechanism. A.

539.172.4

3867. Symmetric fission. T. Sasakawa and T. Sawada. Letter in *Progr. theor. Phys.*, **9**, 324–5 (*March*, 1953).

Small errors in the calculations of Bohr and Wheeler [1939] are pointed out. G. E. BROWN

539.172.4

3868. Uranium-235 thermal neutron fission yields. G. W. Reed and A. Turkevich. *Phys. Rev.*, **92**, 1473–81 (*Dec.* 15, 1953).

The absolute yields of six nuclides in the thermal neutron fission of U^{235} were determined to better than 6%, using fission counting and radiochemical techniques. The results are in good agreement with earlier determinations of lower accuracy. They support mass spectrometric indications of fine structure in the yield-mass curve in low-energy nuclear fission. A.

539.172.4 : 537.214

3869. Coulomb energy of a uniformly charged liquid-drop. O. Miyatake and K. Watanabe. *J. Inst. Polytech. Osaka City Univ. B*, **2**, 15–22 (*Oct.*, 1951).

See Abstr. 748 (1948). A calculation associated with the liquid-drop model of fission. Numerical integration is used. A. E. KAY

539.172.4 : 539.172.3

3870. Photoneutrons in a heavy water pile. M. W. Johns and B. W. Sargent. *Canad. J. Phys.*, **32**, 136–52 (*Feb.*, 1954).

Decay curves of the neutron intensity in the low power heavy water pile (ZEEP) at Chalk River as a function of time from shutdown with cadmium rods were obtained with three proportional counters of different sensitivities. The range of counting rates spanned, including operation at 50 W, was 8×10^5. The durations of steady operation before shutdown were 10, 50 and 230 min. The mean lifetimes and absolute yields of delayed and photoneutron groups were found by analysing each decay curve into a sum of decreasing exponentials and using the theory of pile kinetics. The yields were corrected to infinite irradiation time. These results are compared with data obtained by others. The comparison shows that the energetic γ-rays of fisson products which produce photoneutrons in the heavy water are absorbed to the extent of about 26% in the heavy water and 74% in the uranium rods. A table of recommended mean lifetimes and absolute yields of delayed and photoneutrons is given for use in the kinetics of heavy water piles such as ZEEP. Some quantitative data on the effects of the control plates and shutoff rods are included. A.

539.172.4

3871. Use of atomic piles for nuclear measurements. E. Bretscher. *Trans Instrum. Meas. Conf.*, **1952**, 113–17.

Following a simplified survey of the relations between reactivity, absorption cross-sections and pile period, the author points out that with suitable calibration techniques the pile can be used to detect very small changes in any of the factors affecting the multiplication constant k. Neutron absorption cross-sections relative to boron were found for 41 elements using a technique in which the drift of k due to atmospheric pressure changes were minimized. The method of determining the emission of a sample neutron source in terms of known constants by measuring $\delta = k - 1$ over a range of pile powers is described. A neutron source of known yield together with a known absorber were used to determine the number of neutrons emitted during the spontaneous fission of U^{238} as 2·5 ± 0·2. D. R. CHICK

539.172.4

3872. Proceedings of the Kjeller conference on heavy water reactors. Edited by J. A. Goedkoop and G. Jenssen. *JENER Publ., No.* 7, 238 *pp.* (1953).

A verbatim report of the proceedings, including text of the papers and a transcript of the discussion.

Most of these papers are to be published elsewhere. A short report of the conference appears in *Nucleonics*, **11**, 10–13 (*Dec.*, 1953) and in *Science*, **119**, 28–9 (*Jan.* 1, 1954).

539.172.4

3873. Pile modulation and statistical fluctuations in piles. O. R. Frisch and D. J. Littler. *Phil. Mag.*, **45**, 126–40 (*Feb.*, 1954).

A theory is given of the statistical fluctuation of the number of neutrons in a pile. An experimental verification of this theory is described, and the results of the theory are used to evaluate the accuracy of the measurement of neutron absorption cross-sections with a pile oscillator. A.

539.172.4

3874. The outlook for economic nuclear power. B. L. Goodlet. *Atomics* [*London*] **4**, 311–17 (*Dec.*, 1953).

The interest in nuclear power arises because: the United Kingdom's demand for electricity will soon outstrip the output of coal; also in some parts of the world the energy needed to raise the standard of living is not locally available. World reserves of uranium were taken as being about twenty times as prolific in energy as the coal reserves, assuming all the uranium was burned. The physics of a reactor was briefly described and the production of electricity from the energy released was discussed. A reactor had been designed at Harwell as part of a generating unit which would produce electricity at an estimated cost of about 1d. per kWh. The design of a dual purpose reactor for power plus plutonium production was regarded as unsatisfactory. In a non-military economy such a reactor would not be the most efficient type for economical power. The breeder reactor was discussed, special reference was paid to the "doubling time" which was estimated to be rather long. It was suggested that the shortest route to large scale nuclear power was to build several dual purpose reactors, the plutonium produced being used as fuel in breeder reactors which need be only self sustaining. The economics of nuclear power were discussed and a British coal-fired power station was compared with a natural uranium reactor and its associated generating equipment. It would appear that the cost per unit of electricity would be equal in the above cases if the cost of the nuclear plant was less than two or three times that of the conventional plant. There was at present no certainty that the breeder reactor will be able to produce power at less cost per unit than a conventional plant. The author concluded that nuclear power was a certainty, economic nuclear power a possibility, but cheap nuclear power seemed unlikely. D. R. CHICK

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

3875. Symbols for fundamental particles. E. Amaldi, C. D. Anderson, P. M. S. Blackett, W. B. Fretter, L. Leprince-Ringuet, B. Peters, C. F. Powell, G. D. Rochester, B. Rossi and R. W. Thompson. Letter in *Nature* [*London*] **173**, 122 (*Jan.* 16, 1954). Also in *Phys. Today*, **6**, *No.* 12, 24 (*Dec.*, 1953); *C.R. Acad. Sci.* [*Paris*] **238**, 25–7 (*Jan.* 4, 1954); *Nuovo Cimento*, **11**, 213–14 (*Feb.*, 1954); *Naturwissenschaften*, **41**, *No.* 3, 56 (1954).

An improved nomenclature is proposed for light mesons, heavy mesons, and particles with mass intermediate between that of the neutron and the deuteron; also decay phenomena.

539.18

3876. On the κ-meson. K. Inoue. Letter in *Progr. theor. Phys.*, **9**, 323–4 (*March*, 1953).

An estimate is reported of the order of magnitude of the coupling constant for the first stage ($\kappa^{\pm} \rightarrow \mu^{\pm} + N + \bar{N}$) of an assumed three-stage decay into $\mu^{\pm} + \pi^0 + \pi^0$. W. A. HEPNER

539.18

3877. Models of V-particles. K. Nishijima. *Progr. theor. Phys.*, **9**, 414–30 (*April*, 1953).

Possible models of V-particles, mainly concerned with V^0 (V_1^0)-particles, are investigated systematically on the basis of their characteristic features, using experimental evidence and theoretical requirements such as the stability of nuclei and the charge independence. The latter plays a role for ruling out a proposed decay mode, $V^0 \rightarrow p + \pi^- + \nu$, and the single production of hot V^0-particles, respectively. Since the pair production of V^0-particles seems unlikely according to recent experimental evidence, a model is proposed that is based upon the classification of elementary particles due to the generalization of the Pais' even-odd rule. Introducing a pair of short-lived X-particles yet unobserved, the production and decay of V^0-particles take place through the following interactions:

$$N + N \underset{(g_{even})}{\longrightarrow} X + X, \quad X \underset{(g_{int})}{\longrightarrow} \begin{cases} V^0 + \ldots \\ N + \ldots \end{cases} \qquad V^0 \underset{(g_{odd})}{\longrightarrow} p + \pi^-.$$

The magnitude of coupling constant g_{int} lies between both strong g_{even} and weak g_{odd} and the decay of X into $N + \ldots$ is slightly faster than into $V^0 + \ldots$. Several modifications of this model are shown to be permitted. A.

539.18

3878. The theory of *V*-particles. K. Ono. *Progr. theor. Phys.*, **9**, 524–8 (*May*, 1953).

In order to explain the inconsistency between the production and the decay probabilities of V^0, it is proposed to assume that V^0 has an unknown degeneracy. From the lifetime and the production rate of V^0, the state density of V^0 is estimated to be of the order $\sim 10^{10}/m_\pi c^2$, and from the dispersion of the Q-values for the decay of V^0, the total number of the internal states of V^0 is estimated to be very roughly of the order $\sim 10^{10}$. Using these results, the cross-section for the production of V^0 by the nucleon-nucleon collision is calculated. A.

539.18

3879. Classical theory of charged meson. N. C. Sil. *Indian. J. Phys.*, **27**, 311–22 (*June*, 1953).

The equations of motion of the nucleon in interaction with the charged scalar meson field are solved

assically and the values of total scattering cross-ections of charged mesons by nucleons calculated. he influence of radiation damping is also investigated. A.

539.18

3880. On the nature of the κ-meson. N. DALLAORTA. *Nuovo Cimento*, **11**, 82–7 (*Jan.*, 1954).

Assuming that the κ-meson is a fermion which nteracts with other fermions through the universal ermi interaction, the decay probability and the apture probability by nuclei are calculated. The alues obtained are in quite good agreement with the xperimental data at present available. A.

539.18 : 537.56

Ionization loss of relativistic particles in a gas. *See Abstr.* 3611

539.18

3881. Possible example of a new mode of disintegration of the neutral π-meson. S. GOLDSACK, M. SCHONBERG AND G. VANDERHAEGHE. Letter in *Nuovo Cimento*, **10**, 1480–1 (*Oct.*, 1953).

Discusses an event observed in 1200 μ G5 emulsion exposed at 2000 m which could be interpreted as a charged π-meson scattered by a nucleus with charge exchange. The charged π becomes a neutral π-meson which then disintegrates in flight into an electron and a μ-meson. H. ELLIOT

539.18

3882. "Nonmesonic" bound *V*-particle decay. W. CHESTON AND H. PRIMAKOFF. *Phys. Rev.*, **92**, 1537–41 (*Dec.* 15, 1953).

A theoretical treatment is presented of the apparent relative stability of V-particles in nuclear matter in terms of the process of bound V-particle nonmesonic decay. Mean lives for nonmesonic decay of V-particles imbedded in nuclear fragments such as He, Li, . . . O, are estimated as $\sim 10^{-11} - 10^{-12}$ sec. A very brief discussion is given of the bearing of such relatively long mean lives on possible mechanisms of V-particle production. A.

539.18 : 530.145

Radiative corrections in decay of μ-mesons. *See Abstr.* 3081

539.18 : 537.591.8

3883. Preliminary research on V_1^0 events in emulsions. E. AMALDI, C. CASTAGNOLI, G. CORTINI AND A. MANFREDINI. Letter in *Nuovo Cimento*, **10**, 1351–3 (*Sept.*, 1953).

A preliminary investigation of two-prong stars observed in 600 μ emulsion exposed at 25 km altitude has led to the tentative identification of 6 events as V_1^0 decays. H. ELLIOT

539.18

3884. Determination of the mass of slow particles by the constant sagitta method. C. DILWORTH, S. J. GOLDSACK AND L. HIRSCHBERG. *Nuovo Cimento*, **11**, 113–26 (*Feb.*, 1954).

A method is described in which the measurement of scattering of tracks at the end of their range is carried out on sets of cells of varying length, chosen so that the second difference of the sagitta remains constant. This permits the measurements to be made always at the optimum cell length and eliminates the inconveniences and inaccuracies of the methods in which the track is broken into several sections for measurement. The mass values of a series of K- and J-particles have been determined, together with those of a group of protons which serves as calibration. A.

539.18

3885. Production of π-mesons in neutron-proton collisions. D. BASU. *Indian J. Phys.*, **27**, 347–53 (*July*, 1953).

The cross-section for the production of mesons in a neutron-proton collision, a third order process, is calculated on the basis of the "charged pseudoscalar" theory with "pseudoscalar coupling." If the recoil of the nucleon initially at rest is neglected, the cross-section vanishes. For $g^2 = 0{\cdot}3$, the numerical value of the cross-section is of the order of 10^{-29} cm^2 and the total cross-section increases as $\log E_{p0}$, E_{p0} being the energy of the incident nucleon. The validity of the results for high energies is only restricted by the fact that radiation damping has been neglected. A.

539.18

3886. Meson production in high-energy nucleon-nucleon collisions. W. L. KRAUSHAAR AND L. J. MARKS. *Phys. Rev.*, **93**, 326–30 (*Jan.* 15, 1954).

A model for meson production in high-energy nucleon-nucleon collisions similar to a model suggested by Takagi is discussed. It is assumed that the primary collisions result in the formation of two highly excited nucleons which decay as free particles. Forward and backward centre-of-mass collimation is a natural consequence. Angular momentum is discussed and treated quantitatively by means of thermodynamic arguments similar to those used by Fermi. The model implies a tendency for the mesons to be emitted in a plane. The multiplicities predicted are larger than those predicted from the Fermi model and depend upon an additional parameter related to angular momentum. A.

539.18

3887. On the scattering of μ-mesons by nuclei. R. GATTO. *Nuovo Cimento*, **10**, 1559–81 (*Nov.*, 1953).

Recent experiments have led to unexpectedly large cross-sections for anomalous scattering of μ-mesons. It is here examined whether a better evaluation of the electromagnetic contributions can diminish this discrepancy. The incoherent electric cross-section and the dependence on the nuclear model employed are considered in detail. To calculate the incoherent contribution the closure approximation is used: a discussion is given of its validity and in some cases the results are compared with those of calculations which do not use the closure approximation. It is concluded that the incoherent contribution cannot explain the large anomalous cross-sections. A.

539.18

3888. The signs of the phase shifts for pion-proton scattering. S. W. BARNES, C. E. ANGELL, J. P. PERRY, D. MILLER, J. RING AND D. NELSON. Letter in *Phys. Rev.*, **92**, 1327–8 (*Dec.* 1, 1953).

Using their measured value of $1{\cdot}7 \pm 0{\cdot}4$ cm^2/sterad., at 45° in the lab. system, for the reaction $\pi^- + p \rightarrow \pi^- + p$ at 40 MeV, and other pion scattering data, the

phase shifts are deduced. Assuming the values of α_{11}, α_{13} and α_{31} to be negligible, the phase shifts are:— $\alpha_1 = +9{\cdot}7° \pm 1{\cdot}2°$, $\alpha_3 = -2{\cdot}6° \pm 1{\cdot}4°$, $\alpha_{33} = +5{\cdot}7° \pm 1{\cdot}2°$, no solution existing for reversed signs [notation of Abstr. 7176 (1953)]. J. HUGHES

539.185

3889. Emergence of slow neutrons from a hydrogenous substance. P. C. CAPRON AND E. CRÈVECŒUR. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 6, 562–7 (1953) *In French.*

The cadmium difference method has been used to measure the density distribution of slow neutrons in a hydrogenous substance, as a function of distance from a plane boundary. Small departures were found from the expected linear law. In consequence the neutrons must have emerged from the moderator with a wider angular distribution than theory predicts. J. M. CASSELS

539.185

3890. The depression of neutron flux by a foil detector. A. DE TROYER AND G. C. TAVERNIER. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 10, 880–90 (1953).

The depression of neutron flux in water caused by a gold detector has been determined experimentally by two methods. The result is much greater than simple diffusion theory predicts. Transport theory gives a result slightly too large. J. M. CASSELS

539.185

3891. D, D neutron scattering and polarization effects in C^{12}. R. RICAMO. *Nuovo Cimento*, **10**, 1607–15 (*Dec.*, 1953).

D, D neutron polarization has been established by measuring the azimuthal dependence of the differential cross-section of C^{12}. Experiments allow assignment of a lower limit 20% for the polarization of 3·32 MeV neutrons, emitted at 45° from the deuteron direction for a deuteron energy of 610 keV. Measurements of the angular distribution of scattered neutrons at resonance energy $E_n = 2{\cdot}08$ MeV permit the level to be identified as a D state ($J = 3/2$ or $5/2$). At the energy $E_n = 2{\cdot}20$ MeV, i.e. far from resonances, the angular distribution has the expected theoretical behaviour for the potential scattering. The effect of polarized neutrons on the angular distribution near an isolated level of the $D_{3/2}$ type has been calculated. A.

539.185 : 548.74

On the diffuse reflexion of neutrons by a single crystal. *See Abstr.* 4035

539.185 : 537.591.8

3892. Diffraction effects in the scattering of neutrons, μ mesons and electrons by nuclei. E. AMALDI. *Indian J. Phys.*, **26**, *No.* 12, *Supplement* (*Dec.*, 1952) = *Proc. Indian Assoc. Cultiv. Sci.*, **35**, 1–47 (1953).

In Pt I the author reviews the scattering and absorption of neutrons between 10 and 100 MeV by intermediate and heavy nuclei. At these energies the neutron wavelengths are of the magnitude of nuclear dimensions, and diffraction effects set in. The theory of these effects is discussed in a phenomenological way, and the experimental evidence is presented in detail.

Pt II consists of a review of μ-meson scattering, both experimental and theoretical. It is shown that the scattering of μ-mesons arises almost completely from the electromagnetic interaction, and ways in which the μ-meson can be used to test the charge distribution of the nucleus and that around the individual nucleons are discussed. G. E. BROWN

539.18

3893. Magnetic inelastic scattering of slow neutrons. H. PALEVSKY AND D. J. HUGHES. Letter in *Phys. Rev.*, **92**, 202 (*Oct.* 1, 1953).

The slow-neutron inelastic scattering cross-section of iron was measured using the Brookhaven slow chopper, and found to be an increasing function of the temperature. A change of slope was found at the Curie temperature suggesting that the inelastic scattering is magnetic or "spin wave." The scattering above the Curie point is discussed in terms of the structure of iron in the paramagnetic region. J. HUGHES

539.185 : 532.7

Scattering of slow neutrons by protons of dissociated electrolytes. *See Abstr.* 3176

539.185 : 538.22

3894. Paramagnetic scattering of neutrons by rare earth oxides. W. C. KOEHLER AND E. O. WOLLAN. *Phys. Rev.*, **92**, 1380–6 (*Dec.* 15, 1953).

The magnitude and angular dependence of the paramagnetic scattering of neutrons has been studied for the trivalent ions in the rare earth oxides, Pr_2O_3, Nd_2O_3, and Er_2O_3. These rare earth ions have large angular momentum contributions to their magnetic moments and one object of the investigation was to obtain a better understanding of the magnetic scattering in such cases. The angular distribution of the scattering for samples at room temperature is compared with the theoretical results of Trammell (following abstract). The calculations based on screened hydrogenic wave functions give results in reasonably good accord with the measurements when the screening constant is taken as an adjustable parameter which is then determined, within limits, by the data. Scattering measurements were also made at liquid nitrogen and liquid hydrogen temperatures and within a few percent no changes and, hence, no crystalline field or exchange effects were observed. A

539.185 : 538.222

3895. Magnetic scattering of neutrons from rare earth ions. G. T. TRAMMELL. *Phys. Rev.*, **92**, 1387–93 (*Dec.* 15, 1953).

The differential cross-section for the magnetic scattering of thermal neutrons by paramagnetic rare earth ions is derived theoretically assuming that the ions have Russell Saunders coupling and are in the Hund ground state. Satisfactory agreement with the measured cross-sections of Er_2O_3 and Nd_2O_3 is obtained using hydrogenic radial wave function with $Z - S \simeq 23$ and 20 for Er^{+++} and Nd^{+++}, respectively. A

539.185.08

3896. Activity of a disk-shaped neutron probe. M. A. VIGON. *Z. Naturforsch.*, **8a**, 727–9 (*Nov.*, 1953) *In German.*

A general expression is derived as well as approximate formulae for certain limiting cases. If the self-

sorption of the electrons is considered it is found hat the activity depends as a rule on the orientation f the probe, and that the neutron flux as well as the eutron density must be considered. J. HUGHES

STRUCTURE OF SOLIDS 539.2

539.21 : 537.226.2

Structure and dielectric properties of carbon-black ubber compounds. *See Abstr.* 3449

539.213.2

3897. Physics of the glassy state. I. Constitution nd structure. E. U. CONDON. *Amer. J. Phys.*, **22**, 43–53 (*Feb.*, 1954).

Modern views of the constitution and structure of inorganic glasses are outlined. Materials used in glass making are classified according to their role as network formers and network modifiers. Evidence of structure from X-ray scattering is reviewed. Examples of linear and non-linear dependence of specific volume on composition are presented, and the classical factors for composition dependence of heat capacity are related to quantum theory of specific heat. A.

539.213.2 : 539.27

3898. The structure of vitreous silica. J. S. LUKESH. *Phys. Rev.*, **93**, 264 (*Jan.* 15, 1954).

The appearance of sharp diffraction lines in electron-diffraction patterns of vitreous silica has been interpreted as evidence that the material is crystalline. The method of sample preparation was such as to cause surface devitrification. The conclusions are, therefore, unwarranted. A.

539.215 : 531.74 : 535.417

Interferometric measurement of grain boundary grooves. *See Abstr.* 3338

539.216 : 535.515 : 539.37

3899. On the elastic and optical properties of cellulose fibres. H. DE VRIES. *Delft: Technische Hogeschool* (1953), 111 *pp.*

A detailed investigation of the deformation properties of regenerated, continuous cellulose fibres, in which an attempt is made to provide a basis for the classification of such fibres. The experimental methods concentrate on the elastic properties and Part A deals with the dynamic modulus of elasticity which is determined from measurements of the velocity of sound in the fibres. This modulus (E) is measured as a function of extension for a large variety of regenerated cellulose fibres under standard conditions of temperature and humidity. During the first part of the extension, E remains constant but for greater extensions (X), I/E is proportional to ln $(1 + X)$. In Part B an account is given of the measurement of the double refraction of the fibres. The method of measuring birefringence is based upon the spectroscopic analysis of the light diffracted by a phase grating which consists of regular windings of the yarn being investigated. Full details of the method are given, and no systematic difference was found between the results and those obtained with the more conventional microscopic immersion method. With the new method, however, it is possible to determine the average values of refractive indices over a length of several metres of yarn at once. The birefringence for different extensions was measured and it was found to increase approximately in linear proportion to the extension over the whole range of extension. Part C consists of a discussion of the results and their practical application. J. IBALL

539.217

3900. A method for measuring diffusion coefficients. S. N. KRYUKOV AND A. A. ZHUKHOVITSKIĬ. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 3, 379–82 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-71.*

A method for measuring diffusion coefficients with radioactive tracers in small specimens is described. The tracer is plated on to one side of a thin foil, and the ratio of counting rates from the two sides measured as a function of time. The results are independent of a knowledge of the absorption of the radiation in the material; the estimated final accuracy is 10 to 15%. Result for silver is $D = 1{\cdot}8 \exp(-47400/RT)\text{cm}^2/\text{sec}$. W. M. LOMER

539.217

3901. Measurement of diffusion coefficients. P. C. CARMAN AND R. A. W. HAUL. *Proc. Roy. Soc. A*, **222**, 109–17 (*Feb.* 23, 1954).

For diffusion into a solid from a gas or a liquid solution, the constant-volume method of measuring the diffusion coefficient has distinct experimental advantages. The diffusion equations required are summarized in the present paper and their application is illustrated by typical experiments. To reduce the amount of computation, equations involving error functions have been derived for application to the first stages of a diffusion run. When the diffusion coefficient and/or the sorption coefficient are concentration dependent, the equations in this paper are still applicable if sorption is carried out in suitably chosen steps. When sorption takes place only at the two parallel faces of a slab (film, sheet or plug), simple and rapid methods of calculating D can be used. A.

539.217 : 537.312.6

3902. Some properties of sodium and potassium near their melting points. L. G. CARPENTER. Letter in *J. chem. Phys.*, **21**, 2244–5 (*Dec.*, 1953).

From the specific heat near the melting point (T_m) the author deduces energies of formation of defects which are compatible with activation energies of self diffusion. The deduced concentration of defects at T_m is of the order to be expected from published anomalies in resistance [Abstr. 3632 (1953)].

L. G. CARPENTER

539.217 : 541.183

3903. Contribution to the method of Barrett and Joyner for the determination of pore diameter from the adsorption isotherms of nitrogen. R. MONTARNAL. *J. Phys. Radium*, **14**, 732–3 (*Dec.*, 1953) *In French.*

A procedure is outlined whereby the calculations involved in the application of the method of Barrett and Joyner [*J. Amer. Chem. Soc.*, **73**, 373–80 (1951)] can be simplified without loss of rigour, and without departing from the spirit of the method. S. J. GREGG

539.217 : 541.183

3904. Study of the porosity of solids. Y. CARTARET AND B. IMELIK. *Bull. Soc. Chim. France*, **21**, 65–72 (*Jan.*, 1954) *In French.*

The method of Barrett *et al* [*J. Amer. Chem. Soc.*, **73**, 373 (1951)] in a refined form has been applied to the calculation of the pore distribution curves corresponding to adsorption isotherms of nitrogen on samples of carbon, alumina, and silica gel. The results have been confirmed by low-angle X-ray scattering. Combination of the results with the surface areas obtained by the BET method permits a conclusion to be drawn in some cases as to the "texture" of the solid, e.g. as to whether it is a mixture of a porous and powdery solid. S. J. GREGG

539.219

3905. On the hardening of Al–Ag alloys in thin sheets. A. WINKELMANN AND H. RAETHER. Note in *Naturwissenschaften*, **40**, *No.* 20, 526 (1953) *In German.*

The γ-phase in a 38% Ag (by weight) alloy precipitates much more quickly and completely in a thin (300 Å) sheet than in a bulk specimen. It is suggested that internal stresses and constraints hinder the necessary atomic translations. W. M. LOMER

539.219 : 537.311.31

Electrical resistance of ordered alloys. *See Abstr.* 3462

539.23

3906. Preparation of thin films of Formvar, used as supports for metallic layers in nuclear physics. P. BARREAU, P. LÉGER, J. MOREAU AND P. PRUGNE. *J. Phys. Radium*, **15**, *Suppl. No.* 1, 4 *A*–7 *A* (*Jan.*, 1954) *In French.*

Methods for the preparation, metallization and manipulation of such films are described.

J. J. WILKINS

539.26

3907. Scattering of X-rays by metals at very small angles. B. M. ROVINSKIĬ AND V. M. GENKIN. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 4, 673–75 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-84.*

A beam of Mo X-radiation of angular width 25″ is passed through a thin metal sheet and the broadening of the beam, resulting from low-angle scattering, determined photographically on a plate 170 cm from the samples. Samples of rolled Cu before and after annealing and of cast, of plastically deformed and of sintered Al were so studied. Information on the structural defects of such materials which the results provide, is briefly discussed. A. D. LE CLAIRE

539.26

3908. Novel X-ray diffraction technique for measuring internal stresses in metals. I. SZÁNTÓ. *Acta tech. Hungar.*, **7**, *Nos.* 1–2, 165–86 (1953) *In German.*

Simplifies measurement by two solutions differing in principle; their common feature is that stress determination does not necessitate an accurate knowledge of the distance between the surface of the object and the plane of registration. One of the solutions is to obtain an evaluation mathematically from the relative position of both lines of the characteristic K_α-doublet radiation applied in registration. This method demands a high sensitivity of registration, therefore such accurate measurement of reflections is onl possible with equipment provided with an electroni counter; it can thus be made automatic. The secon method is based upon direct measurement of reflectio angles. The new camera here presented has mad attainable, in testing steel, a degree of precisio identical with that of the results of the current tech nique of radiography, but by a much simpler measur ing procedure. A

539.2

3909. Evaporated carbon films for use in electro microscopy. D. E. BRADLEY. *Brit. J. appl. Phys.*, 65–6 (*Feb.*, 1954).

A method has been developed for producin carbon films suitable for electron microscope specime supports. Carbon is evaporated on to an extremel soluble substrate, which is dissolved away leavin very thin films. A

539.2

3910. Investigation of the faithfulness of plasti replicas for electron microscopy. B. DEUBNER, H KIMMEL AND W. ROLLWAGEN. *Z. angew. Phys.*, *No.* 8, 284–6 (1953) *In German.*

The optical method of multiple fringe interfero metry was used to test the faithfulness with which plastic replica reproduces surface relief. The inter ference pattern from a test object (steps on a fla surface) was obtained directly and then that from replica of it. The steps were only partially visible i the replica and were not at all sharp. It is suggeste that this is due to the free side of the plastic film following roughly the form of the surface, so that th replica generally is of almost constant thickness When the replica is laid on a flat surface, only a inclined notch will remain where the impression o the step should be. The general truth of this pictur was supported by electron microscope observations It is deduced that the replication will be increasingl faithful as the scale of the surface irregularities i reduced. To relate the degree of faithfulness to th fineness of detail, a theoretical treatment in terms o the Fourier components of the surface contours i developed. A "frequency characteristic," as measure of the faithfulness of imaging of a give object, is then derived from the experimental results The authors do not discuss the relevance of thei work to the actual techniques used in electro microscopy,—in particular the differences betwee imaging by reflection a replica placed on a fla supporting surface, and imaging it in transmissio when it is freely suspended on a grid. V. E. COSSLET

539.27 : 537.533.7

3911. Study of single micro-crystals of gold by a three-stage electron microscope. E. SUITO AND N UYEDA. *Proc. Japan Acad.*, **29**, 324–30 (*July*, 1953).

A method is described for producing thin flaky crystals of gold, a few microns across, by reductio of a dilute auric chloride solution by a saturated salicylic acid solution. In the electron microscope these crystals show characteristic striped patterns over their surfaces due to uneven Bragg reflection The method of micro-diffraction in a three-stage electron microscope was used to determine the orientation of the different areas of the crystal. Th

areas were related to the diffracted beams by the dark field method, in which each beam is picked out in turn by the objective aperture, and an image formed of that area contributing to its formation. M. E. HAINE

539.27 : 537.533.73

3912. Study of the thickness of single micro-crystals of gold by electron diffraction method. E. SUITO AND N. UYEDA. *Proc. Japan Acad.*, **29**, 331–6 (*July*, 1953).

Micro-electron diffraction of thin flaky gold crystals gives subsidiary spots around the positions expected from the Bragg condition. It is shown that the position of these spots is directly related to the thickness of the crystal and the orientation of the crystal surface with respect to the irradiating beam direction. Theoretical expressions relating the spot distribution to the thickness are derived from consideration of geometrical relations between the reciprocal lattice and Ewald sphere and the crystal orientation. Examples are given of the application to the measurement of the thicknesses of the aforementioned gold crystals. Results lie between 40 and 100 Å. M. E. HAINE

539.27 : 539.211 : 666

3913. Electron microscopy of the fracture surface of glass. II. N. TERAO AND S. SAKATA. *J. Phys. Soc. Japan*, **9**, 109–14 (*Jan.–Feb.*, 1954) *In French.*

For previous part, see Abstr. 7613 (1952). The mirror surface appearing at the starting point of a crack produced in a glass rod is observed through the electron microscope by the method of the methyl methacrylate-aluminium-chrome shadow-casting replica. First, photographs were taken of the entire view of the replica sample with low magnification and then each part of the mirror surface with a magnification of 400–500 and next with a much higher magnification. Comparison of these photographs shows the morphological variation of the glass fracture surface from place to place. Small circular bodies which appeared on the flat part of the fracture surface were studied. It is presumed that these do not exist actually on the fracture surface but arise from some secondary reaction between the fresh smooth fracture surface of glass and the replica material. Special forms of cracks such as fibre, comb, foil, feather, arch, etc., were observed. A.

539.27 : 539.23 : 536.424

Phase changes with changing thickness of thin metal films. *See Abstr.* 3372

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.32 : 548.1 : 537.228.1

Elastic constants and piezoelectric crystals. *See Abstr.* 3456

539.37

3914. Integrability conditions for the total strain tensor in a finite deformation of a three-dimensional medium. C. PLATRIER. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 5, 490–4 (1953) *In French.*

A direct calculation of the compatibility conditions for (Lagrangian) finite strain components is outlined. J. G. OLDROYD

539.37

3915. The study of the deformed state with the aid of radioactive isotopes. S. I. GUBKIN AND S. A. DOVNAR. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 5, 1089–90 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-145.

Holes are drilled through the object to be distorted and are plugged with dowels, the surfaces of which are radioactive. After deformation, the object is sectioned at the desired place perpendicular to the dowels and radioautographs are taken from the cut face which show how the circular sections of the dowels become distorted. A. L. MACKAY

539.37 : 535.41

The determination of strain by mechanical interference. *See Abstr.* 3335

539.373

3916. The surface deformation caused on iron crystals by unidirectional abrasion. R. P. AGARWALA AND H. WILMAN. Letter in *Proc. Phys. Soc.* [*London*] *B*, **66**, 717–19 (*Aug.*, 1953).

Iron single crystals, of low carbon content, lightly abraded on 0000 emery at 3 in./sec, examined by reflection electron diffraction, show rotation of fragments about well defined axes. [Results similar to earlier work, Abstr. 3190 (1951)]. Etching to the level where rotation of fragments is small reveals regions deformed by flexural translational slip. Slight etching reveals f.c.c. γ-iron formed in the surface region as a result of abrasion of b.c.c. α-iron. It is suggested that the speed of sliding is adequate to produce local temp. $\geqslant 900°C$, to permit transformation $\alpha \rightarrow \gamma$, and the cooling rate is sufficient for γ-iron to be retained at room temp. The orientation relation is given as $(001)\gamma \,||\, (01\bar{1})\alpha$ with $[\bar{1}10]\gamma \,||\, [\bar{1}11]\alpha$ in common plane; γ-iron is heavily twinned in thin lamellae || to $\{111\}\gamma$. The mechanism of transformation is explained in terms of simple atom movements. J. W. MENTER

539.373 : 539.27

3917. Electron microscopic investigation of slip bands. R. I. GARBER AND A. I. KOVALEV. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 5, 901–4 (1952) *In Russian.*

Shadowed silica replicas of cleavage face of deformed rock salt crystals show presence of cracks adjacent to slip bands. Hardening of crystals by deformation under water explained by removal of cracks by solution of surface layers. J. W. MENTER

539.374 : 539.621

3918. An improvement in plastic pressure experiments by enforced sliding friction. E. MÖNCH. *Z. angew. Phys.*, **5**, *No.* 10, 363–9 (1953) *In German.*

The basic ideas underlying a new procedure for experiments on plastics, in which pressure and lateral frictional forces are applied, is described. The method, which can also be used for metals, is not suitable for routine measurements. H. G. JERRARD

539.38 : 539.67

3919. Internal friction of molybdenum during tensile deformation. R. E. MARINGER. Letter in *J. appl. Phys.*, **24**, 1525 (*Dec.*, 1953).

The internal friction Q rises sharply at or slightly before plastic strain occurs and then suddenly decreases a little just after the discontinuous yield. With increasing load and concomitant strain-har-

dening, Q again increases, approximately linearly with the stress and at a rate which increases with increasing strain rate. A. D. LE CLAIRE

539.4.011

3920. Note on the stress dependence of the activation energy of the rupture process. E. W. LaRocca. Letter in *J. appl. Phys.*, **24,** 1523–4 (*Dec.*, 1953).

The time to rupture under constant stress behaves according to a rate-process law in Ni–Cr–Fe alloy at temp. between 900°c and 1150°c. The activation energy depends on stress, and is 36 kcal at 5380 lb/in^2 and 48 kcal at 7500 lb/in^2. W. M. LOMER

539.4.014 : 548.7

3921. On the orientation-dependence of the hardening curves of cubic face-centred metal crystals. P. Haasen. *Z. Phys.*, **136,** *No.* 1, 26–39 (1953) *In German.*

The calculation of the dependence of the form of the hardening curve on orientation of the stress axis relative to the crystal axes [Abstr. 6094 (1952)] is extended to cover crystals already hardened by strain. A mechanism is considered whereby displacements in the principal glide-planes cause slip in "latent" glide-planes, with consequent hindrance to further slip on the principal plane. The theory satisfactorily explains experimental data at present available. A. R. STOKES

539.415

3922. The dynamic mechanical properties of some organic glasses. J. J. Benbow. *Proc. Phys. Soc.* [*London*] *B*, **67,** 120–30 (*Feb.*, 1954).

The dynamic shear properties of two organic glasses, 2′-hydroxy-2 : 4 : 4 : 6 : 5′-pentamethylflavan and glycerol sextol (cyclo-hexanol) phthalate, were studied at frequencies between 10^{-4} c/s and 10^4 c/s. A brief outline is given of similar measurements on other types of materials and the measured properties of the two glasses are contrasted with those of polymethyl methacrylate in detail. Calculations have been made of the approximate relaxation-time spectra and it is shown that the behaviour of hydroxy-pentamethylflavan is governed by a single activation process over the major part of the frequency range considered. The results suggest that a correlation exists between the mechanical and chemical properties of the glasses. A.

539.42

3923. Single crystal metal rotors. J. W. Beams. Letter in *Phys. Rev.*, **92,** 502 (*Oct.* 15, 1953).

The strength of a single-crystal sphere of iron was investigated by spinning it magnetically at high speed. A cylindrical specimen of zinc was spun about the hexagonal axis. Approximate yield strengths were:—in iron 30 000 lb/in^2; in zinc 5 800 lb/in^2. W. M. LOMER

539.43

3924. Discontinuous flow in zinc crystals and its relationship to strain ageing. M. J. Dumbleton. *Proc. Phys. Soc.* [*London*] *B*, **67,** 98–104 (*Feb.*, 1954).

It was found that nitrogen-treated zinc crystals could strain-age under an applied stress, and also during creep provided the creep rate was small enough. A repeated yielding, strongly dependent on temperature and rate of strain, and which seemed to be due to strain ageing during flow, was observed in stress-strain tests. Jerky flow in stress-strain tests, and jerky stress-relaxation curves were observed over a much wider range of conditions, and appeared also to be due to the presence of nitrogen acting in some manner other than strain ageing. A.

539.62

3925. Studies in glass-cleaning procedures by static friction measurement. K. Kinosita. *J. Phys. Soc. Japan*, **8,** 782–90 (*Nov.–Dec.*, 1953).

Static friction of cleaned glass surfaces was accurately measured, with the aim of establishing a practical scale for the cleanness of the surface and comparing the power of various cleaning procedures. The coefficient of static friction μ of a cleaned glass surface is characteristic of the cleaning procedure adopted. Samples prepared by the same procedure yield the same value of μ within a few per cent, if close attention is paid to the method of treatment. Some practical problems of cleaning technique, preservation of cleaned samples, etc., are dealt with. The relation between μ and the nature of the surface is briefly discussed in conclusion. A.

539.62

3926. Friction of an elastic solid. A. S. Lodge and H. G. Howell. *Proc. Phys. Soc.* [*London*] *B*, **67,** 89–97 (*Feb.*, 1954).

A study in terms of elastic asperity theory is made of the empirical frictional relation $F = \alpha R^n$ where F and R are frictional force and normal reaction respectively, α is a coefficient of friction and n a friction index. Three different contact cases are treated: (i) plane surfaces, (ii) cylindrical surfaces, (iii) a string round a cylinder. Expressions are derived for F (or the tension in case (iii)) in terms of R and the size, number and elastic constants of the asperities. This enables the frictional "constants" to be related to these properties. A.

539.67

3927. Anelasticity of quartz. R. K. Cook and R. G. Breckenridge. *Phys. Rev.*, **92,** 1419–23 (*Dec.* 15, 1953).

By means of the piezoelectric effect, measurements were made of the variation with temperature of (1) the Q of quartz bars executing free acoustical oscillations in torsion, and (2) the equivalent series electrical resistance of bars driven at their natural frequencies of longitudinal acoustical oscillations. For each of the bars studied, it was found that the internal dissipation had a maximum value at a temperature between room temperature and the quartz inversion temperature of 573°c. Measurements of resistance were made on one bar at several different frequencies. These data showed that part of the dissipation was due to a relaxation effect, whose decay time varied with temperature according to an Arrhenius equation. An activation energy of 22 kcal/mole and a relaxation-time constant of 2×10^{-14} sec were deduced from the data, which showed also that the fraction of energy lost during each sinusoidal cycle of strain was independent of the frequency of vibration. Estimates of the activation energies and relaxation-time constants were deduced for the other bars measured. In one case, the dissipation was due to the migration of gold atoms from the electrodes into the quartz lattice. A.

PHYSICAL CHEMISTRY 541

541.1

3928. A note on the kinetics of unitary processes. S. A. RICE. Letter in *J. chem. Phys.*, **21**, 2227 (*Dec.*, 1953).

On the basis of a number of postulates regarding transition probabilities of a system between the states E_s, E_{s-1} and E_{s+1} it is shown that $\partial c_s/\partial t = -(k_s + l_s)C_s + k_{s-1}C_{s-1} + l_{s+1}C_{s+1}$, where C_s, C_{s-1} and C_{s+1} are the probabilities of finding states E_s, E_{s-1}, E_{s+1} and k_s, k_{s-1} and l_s, l_{s+1} are (propagative and degradative) constants. The equation is shown to yield familiar results in the kinetics of monolayer adsorption at a gas/solid interface and for the rate of uptake of dyes by proteins. W. GOOD

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.12 : 539.13/.132

Homogeneous gas processes and time-dependent perturbation theory. *See Abstr.* 3703

541.121

3929. Effect of electrolytes on reaction equilibria between ions of equal sign and different valency. S. KILPI, K. S. MIKKOLA AND M. K. VALANKI. *Ann. Acad. Sci. Fennicae AII, No.* 52, 7 *pp.* (1953) *In German.*

Results of measurements of equilibrium constants of the reactions $CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$ and $2HPO_4^{2-} \rightleftharpoons H_2PO_4^- + PO_4^{3-}$, in KCl, NaCl, NaBr, $NaClO_4$ and Na_2SO_4 solutions of different concentrations, are graphed and tabulated; they are in good agreement with Brönsted's theory of ionic interaction. F. LACHMAN

541.123.1

3930. A method for studying gaseous disproportionation reactions of the type $nA = mB + (n - m)C$. A. W. SEARCY. Letter in *J. chem. Phys.*, **21**, 2244 (*Dec.*, 1953).

Many interesting gaseous reaction equilibria of this type (e.g. the disproportionation of the mixed halides GeF_2Cl_2 and PF_2Br) cannot be investigated by measurements of vapour density since the latter is independent of the degree of disproportionation. Using the Knudsen effusion equations it is shown that at a given temp. the partial pressure of the species A, B, and C may be determined from a knowledge of the total weight loss of a sample per unit area per unit time, the total pressure, and the stoichiometric coeffs. n and m. The molecular weights of the products, B and C, should differ appreciably. W. GOOD

541.123.5

3931. Kinetics of isotope-exchange reactions of fluorine with some halogen fluorides. R. M. ADAMS, R. B. BERNSTEIN AND J. J. KATZ. *J. chem. Phys.*, **22**, 13–21 (*Jan.*, 1954).

Quantitative kinetic data on the isotope-exchange reaction of fluorine with chlorine trifluoride, bromine pentafluoride, and iodine heptafluoride have been obtained using F^{18} ($t_{\frac{1}{2}} = 112$ min) tracer. The materials were handled in a metal vacuum line, and the exchanges were carried out in a 2-litre nickel reaction vessel at three temperatures in the range 181–257°C. While the experimental data do not uniquely determine the mechanism, they strongly suggest that exchange takes place either through a heterogeneous catalysis by the metal fluoride coating on the walls of the reaction vessel, or by a combination of the heterogeneous mechanism plus a homogeneous gas-phase exchange in those cases where a measurable amount of dissociation of the halogen fluoride occurs at the temperature of exchange. It has been shown to be unlikely that the observed exchanges take place through either an atomic mechanism or a purely homogeneous mechanism. It has also been shown that all fluorine atoms in the halogen fluoride molecules are exchangeable. A.

541.123.5 : 539.16

3932. The theory of radioactive ion exchange. E. PITTS. *J. chem. Phys.*, **22**, 56–65 (*Jan.*, 1954).

Experiments reported by other workers have shown that when a precipitate of silver bromide is shaken with a solution containing either silver or bromide ions, some of which are radioactive, the radioactive strength of the solution decreases. The final value reached corresponds to a uniform distribution of the active material throughout both solid and solution. No agreement on the interpretation of these results has up until now been reached. Two possible mechanisms for this exchange are described, and their consequences are examined. A new theoretical treatment is given which includes a consideration of the effect of the spread in crystal sizes, which was neglected in previous discussions of the problem. From those results, a new method of comparison between theory and experiment is suggested. This shows unambiguously that the exchange of silver ions is in agreement with predictions based on the hypothesis that the ions diffuse through the solid. It is shown that the exchange of bromide ions cannot be explained in this way. Values obtained for the diffusion constant of silver are in fair agreement with those from other sources. The relation of these results to the various suggestions put forward by other workers is discussed. A.

541.124

3933. A perturbating factor on the kinetics of the homogeneous hydrogen deuterium exchange reaction. C. BOATO, G. CARERI, A. CIMINO, E. MOLINARI AND G. G. VOLPI. Letter in *Nuovo Cimento*, **10**, 993–4 (*July*, 1953).

The 1935 experiments of A. and L. Farkas on this reaction were repeated, using a Nier mass-spectrometer for the gas analysis. Reproducibility of results was spoiled by the diffusion of air, which catalyses the reactions, through the reaction vessel. This was overcome by enclosing the vessel in a vacuum jacket, and prolonged out-gassing. So far the results indicate lower reaction rates than those found by earlier workers. A. J. TAYLOR

541.126

3934. The initiation sensitivity of the secondary explosives. R. SCHALL. Note in *Z. Naturforsch.*, **8a**, 676 (*Oct.*, 1953) *In German.*

A formula is derived under certain assumptions for the minimum energy that must be imparted to a secondary explosive on a plane surface if the explosive is to detonate immediately. The formula yields a good agreement between the calculated and observed limiting charges for PbN_6. F. LACHMAN

541.126 : 537.221

The electrostatic ignibility and electrification of finely powdered Hexamine. *See Abstr.* 3427

541.126 : 614.83 : 537.221

The ignition of explosives by condenser discharges—effect of added circuit resistance. *See Abstr.* 3428

541.126.2 : 536.461

Flame propagation: the effect of pressure variation on burning velocities. *See Abstr.* 3377

541.126.4

3935. Note on the interaction of methane and water vapor in the hydrogen–oxygen reaction. A. LEVY. *J. chem. Phys.*, **21**, 2132–3 (*Dec.*, 1953).

The influence of methane on the hydrogen–oxygen reaction was studied in the region of the second-explosion limit. The experimental data show that there exists a critical concentration of methane, below which both methane and water vapour produce an identical reduction of the explosion limit. Observations on the course of the slow reaction also show that the accelerating effects of these additives on the rate of combination of hydrogen and oxygen are directly related to one another. It is postulated, on the basis of both the explosion and slow reaction rate data, that methane and water vapour influence the kinetics of the hydrogen–oxygen reaction by similar processes.

A.

541.127

3936. Kinetics of fixation of atmospheric nitrogen at elevated temperatures. H. WISE AND D. I. BAKER. Letter in *J. chem. Phys.*, **21**, 1904–5 (*Oct.*, 1953).

Nitrogen fixation is studied by means of recent information on the kinetics of reaction of nitric oxide. The partial pressure of NO is calculated from the rate expression for the formation of NO as a function of the reactor temperature and of the residence time required to form the given concentration. The expression for the rate of thermal decomposition of NO is transformed to give the fractional change of moles of NO in terms of a rate of cooling. It is deduced that at a reactor temperature in the region of 2800°K the cooling rates required to freeze the composition of the gas mixture at 90% of the equilibrium NO value are of the order of 10^5 to 10^6 °K per sec. Methods of attaining these conditions experimentally are briefly mentioned. H. H. GREENWOOD

541.127

3937. Kinetics of the fast reaction between nitrogen dioxide and fluorine. R. L. PERRINE AND H. S. JOHNSTON. *J. chem. Phys.*, **21**, 2202–5 (*Dec.*, 1953).

The rate of the reaction between nitrogen dioxide and fluorine to form nitryl fluoride was measured at 27·7, 50·4, and 70·2°. Light absorption by nitrogen dioxide was used to follow the reaction. By using a 22 l Pyrex flask and by going to low concentrations of reactants, between 0·5 and 20×10^{-8} moles cm^{-3}, the rate of this fast reaction was reduced to a convenient value. The rate was found to be first order in each reactant, and it showed no dependence on nitryl fluoride. The proposed mechanism is: k_1: $NO_2 + F_2 \rightarrow NO_2F + F$ (slow), k_2: $NO_2 + F + M \rightarrow NO_2F + M$ (fast). The empirical second order rate constant is k_1, that of an elementary bimolecular reaction. If the rate constant is written as $Ae^{-E/RT}$ then A is $1\cdot6\times10^{12}$ cm^3 $moles^{-1}$ sec^{-1}, and E is 10·5 kcal. A.

541.127

3938. The kinetics of the heterogeneous para-hydrogen conversion. Y. L. SANDLER. Letter in *J. chem. Phys.*, **21**, 2243–4 (*Dec.*, 1953).

Assuming a first-order rate law for the conversion a simple equation is derived showing the relation between the observed activation energy E and the "true" activation energy of the surface reaction. The equation is applied to the data for the conversion of p-H_2 on tungsten surfaces and leads to a reaction order much greater than the experimental one. It is pointed out that no conclusions should, however, be drawn from the discrepancy before kinetic and adsorption experiments have been carried out on the same surface. W. GOOD

541.127

3939. Kinetics of the reaction of ethyl bromomalonate with thiosulfate. W. J. BROACH AND E. S. AMIS. *J. chem. Phys.*, **22**, 39–42 (*Jan.*, 1954).

The effect of changing the dielectric constant and the effect of changing the ionic strength on the reaction between thiosulphate ion and ethyl bromomalonate have been studied. The rates of the ion-molecule reaction could be accounted for on the basis of the simple second order mechanism between the dipolar ester molecule and the thiosulphate ion represented by the equation

$$C_2H_5OOCCHBrCOOC_2H_5 + S_2O_3^{=} = C_2H_5OOCCH(S_2O_3)^{-}COOC_2H_5 + Br^{-}$$

and considering the change of ionic strength with extent of reaction to be secondary in importance. The reactions of thiosulphate ion and ethyl bromomalonate was studied at 0·1°c and at 25°c. The specific reaction rates for this reaction conformed to the prediction of the Amis-Jaffe equations with respect to changing ionic strength and conformed to the Amis equation with respect to changing dielectric constant. A.

541.127.1

3940. Fractionation of the carbon isotopes in decarboxylation reactions. VI. Comparison of the intermolecular isotope effects of a pair of isotopic isomers. J. BIGELEISEN AND M. WOLFSBERG. *J. chem. Phys.*, **21**, 2120–1 (*Dec.*, 1953).

For Pt IV, see Abstr. 7343 (1951). Theoretical considerations show that malonic acid $-2C^{14}$ should decarboxylate precisely twice as fast as the isotopic isomer malonic acid $-1C^{14}$ liberates $C^{14}O_2$. The

calculations are supported by the experimental data of Ropp and Raaen. It is shown that these experiments are consistent with a C^{14} isotope effect twice that of the C^{13} one. A.

541.127.3

3941. Temperature gradients in reacting systems. S. W. BENSON. *J. chem. Phys.*, **22**, 46–50 (*Jan.*, 1954).

A study of the heat conduction equation for reactions going on in a spherical flask leads to a calculation of three parameters, τ, the mean lifetime for the establishment of stationary states, ΔT_m the maximum temperature difference between the walls of the vessel and the reacting gas, and the average temperature difference $\langle \Delta T_m \rangle_{Av}$. These are given by: $\tau = \rho c_v r_0^2/\pi^2 K$; $\Delta T_m = RHr_0^2/6K$; $\langle \Delta T_m \rangle_{Av} = RHr_0^2/15K$ in which ρ is the density, c_v the specific heat at constant volume, r_0 the radius of the vessel, K the coefficient of thermal conductivity, R the specific rate of reaction, and H the heat of reaction. In liquid systems under usual conditions τ is of the order of r_0^2 min (r_0 in cm) while $\langle \Delta T_m \rangle_{Av}$ is about $\pm 0{\cdot}2$°C (for $H = \pm 10$ kcal, half life = 1 hr, $r_0 = 5$ cm) so that such effects are usually negligible. In gases on the other hand $\langle \Delta T_m \rangle_{Av}$ can be of the order of magnitude of 2°C or higher depending on the various conditions, resulting in significant errors in observed rate constants and activation energies. The effects of added inert gases, pressure, vessel packing, and other parameters are discussed. A very crude treatment of convection shows that it is not expected to alter appreciably the magnitude of $\langle \Delta T_m \rangle_{Av}$. A.

541.128 : 548.7

3942. The question of the interdependence of the condition of the crystal lattice of a catalyst and its activity. P. F. IPATOV. *Zh. fiz. Khim.*, **27**, *No.* 8, 1133–6 (1953) *In Russian.*

Specimens of MoO_2 were produced by the calcination of MoO_3 at various temperatures (500–660°) for ½ to 1 hour. X-ray powder photographs were taken and photometered, showing that the ratio of the intensities of high to low orders of the same reflecting plane decreased towards the theoretical value with increasing temperature. This indicated that specimens calcined at high temperatures were more crystalline. The increased crystallinity is correlated with the sharp decrease in catalytic activity on heating. A. L. MACKAY

541.128.3

3943. Sintering of a water gas shift catalyst. J. HOOGSCHAGEN AND P. ZWIETERING. Letter in *J. chem. Phys.*, **21**, 2224 (*Dec.*, 1953).

The internal surface area, A, of the (porous) catalyst is assumed to decrease due to sintering at a rate proportional to the $(n+1)$th power of the existing area and the relation $1/A^n - 1/A_0^n = k\tau \exp(-E/RT)$ adduced; E = activation energy of the sintering process, T = sintering temp., τ = sintering time. The relation is verified experimentally with a $Fe_2O_3 - Cr_2O_3$ catalyst. The catalytic first-order activity constant was measured at 350°C on each sintered sample. Its variation with T and τ accords with the hypothesis of the one-dimensional series of sinter states. W. GOOD

ELECTROCHEMISTRY 541.13

541.13

3944. On the kinetic analysis of the discharge mechanism of complex ions. H. GERISCHER. *Z. phys. Chem.*, **202**, 292–301 (*Oct.*, 1953) *In German.*

The kinetic equations for the discharge of coupled ions are derived and discussed. Expressions are found for the current density and the equilibrium potential as functions of the activities of the ions taking part in the reaction. It is shown, by the use of these equations, how it can be found which reaction determines the rate of discharge. A. J. TAYLOR

541.13

3945. Kinetics of the discharge of simple and complex zinc ions. H. GERISCHER. *Z. phys. Chem.*, **202**, 302–17 (*Oct.*, 1953) *In German.*

The analysis of the discharge mechanism presented in the preceding abstract can be applied if the current density of material exchange can be measured. The discharge of complex ions proceeds in various stages over complexes with lower co-ordination number. The influence of simple ions on the rate of discharge is negligible; this agrees with the former theory of direct discharge. The apparatus used and the experimental details of measurements on various zinc complexes are described. A. J. TAYLOR

541.132

3946. The driving force for formation of non-classical ions. H. M. WALBORSKY. *Experientia*, **9**, *No.* 6, 209–10 (1953).

It is suggested that the formation of non-classical ions is characteristic of strained systems. Hence the driving force for the formation of a non-classical ion seems to be the relief of strain, that accompanies the ion formation. F. LACHMAN

541.132

3947. Formation of complexes between the Ag^+ and Br^- ions in aqueous solutions. E. BERNE AND I. LEDEN. *Z. Naturforsch.*, **8a**, 719–26 (*Nov.*, 1953) *In German.*

Potentiometric and conductivity measurements have revealed the existence of single-nucleus complexes $AgBr_n^{(1-n)-}$ with n values = 1, 2, 3 and 4; the corresponding constants have been calculated. A weak concentration of formed multinuclear (Ag_m) complexes has been detected. The solubility product values have been measured for different ionic strengths. F. LACHMAN

541.132

3948. On the theory of electron-transfer processes in aqueous solutions. J. WEISS. *Proc. Roy. Soc. A*, **222**, 128–41 (*Feb.* 23, 1954).

It has been realized for some time that simple electron-transfer processes play an important part in the mechanism of many oxidation-reduction reactions in solution. An attempt has been made to give a quantum-mechanical interpretation of these processes on the basis of the earlier theories of electron transfer in the gaseous state [Landau (1932); Bates and Massey (1943)]. The present treatment for

solutions takes into account the rôle of the solvent, with particular reference to the operation of the Franck–Condon principle and it also leads to some definite picture of the transition state for the electron transfer process. A number of examples are discussed, including electron transfer between like ions of different valency and also reactions involving complex ions, e.g. metal porphyrins, the reactions of which are of importance in certain biochemical processes. It appears that the application of certain theoretical principles leads to a satisfactory understanding of electron-transfer processes in solution from a qualitative and, in some cases, also from a semi-quantitative point of view. A.

541.132 : 536.75

3949. The entropy of aqueous oxy-anions. R. E. Connick and R. E. Powell. *J. chem. Phys.*, **21**, 2206–7 (*Dec.*, 1953).

The entropies of oxy-anions of the formula XO_n^{-Z} are well represented by the equation $\bar{S}_2^0 = 43{\cdot}5 - 46{\cdot}5(Z - 0{\cdot}28n)$. Species containing hydroxyl groups are included by disregarding the hydroxyl groups in counting the number of oxygens, n. The form of the equation is partially justified on the basis of a model. Binuclear ions are treated by calculating for the two halves separately and making a correction for the entropy of dimerization. A.

541.135

3950. The molar activity coefficients of electrolytes predicted from conductivity data. H. P. Marshall and E. Grunwald. *J. chem. Phys.*, **21**, 2143–51 (*Dec.*, 1953).

The molar activity coefficients of uni-univalent electrolytes may be predicted on the basis of conductivity data with an accuracy of at least 1% up to concentrations of the order of 0·01 M in solvents of dielectric constant as low as 10. The method is based on Bjerrum's theory of ion association, with the ion pair dissociation constant evaluated from conductivity data. The success of the method depends on the use of expressions for y', the quasi-activity coefficient of the dissociated fraction, and for Λ, the equivalent conductivity, which go beyond the limiting law approximations of the interionic attraction theory. Equations have been developed for this purpose. In solvents of dielectric constant 10–40 the prediction involves no adjustable parameters characteristic of the electrolyte. The equations have been tested by comparing the conductivity-predicted y values for hydrochloric acid with those determined from e.m.f. measurements. To ensure the significance of this comparison, new e.m.f. data for the cell $Pt–H_2(g)/HCl\ AgCl–Ag$ have been obtained for 82·00 wt % dioxane ($D = 10{\cdot}56$) in the concentration range 0·0001–0·01 M. A.

541.135 : 548.52

3951. On the theory of electrolytic crystal growth. W. Lorenz. *Z. phys. Chem.*, **202**, 275–91 (*Oct.*, 1953) *In German.*

The kinetics of a simple metallic electrode are described. The causes which determine the polarization of an electrode are investigated qualitatively. The field distribution in a crystal plane is calculated under the conditions that the current is steady, and that ion discharge takes place only at the points of crystal growth. This boundary-value problem is solved subject to some assumptions which are usually justified. A relation is found between the polarization potential, the current density, the electrolytic conductivity, the surface conductivity, the diameter of the area of growth and the number of deposited ions per cm². The results are applied to the theory of metallic overvoltage. Some new nomenclature is introduced. A. J. TAYLOR

541.135.6 : 548.5

3952. Polarization phenomena in the electrocrystallization of silver. I. Malinovski and E. Budevski. *Izv. Bulg. Akad. Nauk*, **2**, 205–26 (1951) *In Bulgarian.*

Investigations of the electrolytic growth of spherically curved silver crystals enabled, by comparatively well-defined surface conditions, the relation between electrochemical polarization and polarizing current density to be measured. The appearance of regular crystallographic forms on the previously rounded single silver crystals indicates that at least initially the deposition of silver atoms over the whole surface is uniform and not concentrated at certain "active" points. The measurements also showed that the electrode potential in cathodic as well as anodic polarization varies linearly with increasing current density, though the proportionality factor is very small. A certain difficulty arose in separating this variation of potential from the resistive drop on the path of the polarizing current, especially at high current density, though an approximate calculation of the resistance of the thin layer of electrolyte between the reference electrode and the electrode surface is possible. Thus the greater part of the measured change of electrode potential is due to the resistive drop. The smaller part remaining is of the same order of magnitude as the concentration polarization calculated with the extrapolated value of the limiting current density. Another possibility of separating concentration polarization from resistive drop is based on the temperature relation of the polarization. Lastly, the time relation of the electrode potential variation of an electrode polarized by a constant current was observed. B. F. KRAUS

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.14/.15

3953. Moderation of hot methyl radicals in photolysis of methyl iodides. F. P. Hudson, R. R. Williams, Jr and W. H. Hamill. Letter in *J. chem. Phys.*, **21**, 1894 (*Oct.*, 1953).

The effect of moderating gases on the rate of methane production in the photolysis of methyl iodide is discussed. Experimental evidence is brought forward to rule out the possibility of a specific chemical effect and to support the hot radical hypothesis. H. MILLER

541.14

3954. Photochemical processes in AgCl–Ag_2S mixed crystals. E. SCHÖNE. *Z. Phys.*, **136**, *No.* 1, 52–6 (1953) *In German.*

Solid solutions of AgCl with 0·01 mol % Ag_2S were irradiated at −186°C with light from a high pressure mercury arc (4060 Å). Measurements of absorption after exposure revealed 5 absorption bands with peaks at 4380, 4850, 5150, 5700 and 6600 Å, the first two generally narrow and well defined. Rise of temp. before measurement intensified the bands of shorter wavelength and reduced the others. S. T. HENDERSON

541.14

3955. Primary photochemical process in bromine. G. B. KISTIAKOWSKY AND J. C. STERNBERG. *J. chem. Phys.*, **21**, 2218–23 (*Dec.*, 1953).

A kinetic investigation of the photobromination of ethylene has led to results which are in general consistent with the earlier work of Schumacher *et al.* The existence of an induced oxidation reaction was demonstrated in mixtures containing traces of oxygen, which is a very strong inhibitor of the ethylene-bromine chain reaction. The relative quantum yields of the photobromination reaction were measured at six wavelengths using narrow pass Baird interference filters. The quantum yields were shown to be independent of wavelength between the limits of 4800 and 6800 Å. Radiation of 7150 Å wavelength is absorbed but is totally ineffective photochemically. These results were interpreted with the aid of spectroscopic information to mean that the photochemically effective transitions of bromine molecules in radiation of wavelengths longer than the convergence limit, 5107 Å, lead to the continuum of the $^3\pi_{1u}$ state, which then dissociates in one elementary act to form two normal atoms. It is unnecessary to invoke the assumption of collisional dissociation of excited bromine molecules to explain their photochemical reactivity below the convergence limit. A.

541.14

3956. A method for determining quantum yields of reactions initiated by mercury-6($^1P_1$)-atoms. R. A. UPHAUS AND H. E. GUNNING. Letter in *J. chem. Phys.*, **21**, 2229 (*Dec.*, 1953).

It is pointed out that the study of reactions photosensitized by Hg6($^1P_1$) atoms produced by the resonance line 1849 Å is complicated by the need to prevent the production by the resonance line 2537 Å of Hg atoms in the state 6($^3P_1$). The complication is avoided by taking advantage of the very different absorption coefficients of Hg vapour for the two lines. The partial pressure of the Hg vapour in the photocell (containing propane) was varied by varying the temp. of liquid Hg in an adjoining finger trap. The correspondingly varying fractional absorptions, A_1 and A_3, of 1849 Å and 2537 Å radiation can be calculated by familiar methods, the effective cross-section for Lorentz broadening of the propane being known. The quantum yield, Q_1, for the reaction initiated by Hg6($^1P_1$) atoms was determined from the rate, R_{H_2}, of production of hydrogen since $R_H = A_1I_1Q_1 + A_3I_3Q_3$, I_1 (determined by NH_3 photolysis) and I_3 being the total emitted intensities of the two lines and $Q_3 = 0{\cdot}46$ being the known quantum yield with Hg6($^3P_1$). It was found to be 0·38. W. GOOD

541.15

3957. Deterioration of the crystallinity of wet ribonuclease with exposure to X-radiation. B. S. MAGDOFF. Letter in *Acta cryst.*, **6**, 801–2 (*Oct.*, 1953).

Films taken after 11 hr and after 143 hr of irradiation with 40 kV X-rays showed identical diffraction patterns. After 185 hr a very weak pattern was obtained (plates given). A given microphotograph of the irradiated crystal shows a "punched out" cylinder equal in diameter to that of the X-ray beam used. Unirradiated parts are not affected. D. V. MABBS

541.15

3958. The crosslinking of rubber by pile radiation. A. CHARLESBY. *Atomics* [*London*] **5**, 12–21, 27 (*Jan.*, 1954).

Rubber becomes cross-linked when exposed to high-energy radiation so that the variation of properties with degree of cross-linking can be studied without the intervention of chemical agents. Swelling properties of highly cross-linked rubber, the gel fraction of lightly cross-linked rubber, and the viscosity of the sol fraction are described, and a mathematical theory is given. Swelling measurements show that degree of cross-linking is proportional to radiation dose, and elastic measurements confirm this. Observed variation in the gel fraction with radiation dose follows the theory. The average molecular weight can be deduced from the radiation dose required to initiate gel formation and from the variation of gel fraction with dose. Similar results are obtained from viscosity measurements, but these are less reliable. The Flory–Higgins swelling relationship is investigated for very lightly cross-linked gels. Cross-linking efficiency for rubber is compared with that for other long-chain polymers. C. B. ALLSOPP

541.15

3959. The cross-linking and degradation of paraffin chains by high-energy radiation. A. CHARLESBY. *Proc. Roy. Soc. A*, **222**, 60–73 (*Feb.* 23, 1954).

n-Paraffins from C_7H_{16} to $C_{36}H_{74}$ and polyethylene polymers (Polythene and Winnothene) were subjected to atomic pile radiation. For the paraffins there is a decrease in the melting-point, until, for a radiation dose R, they no longer melt at temperatures of 160°c or above. At about this same radiation the paraffin is turned into an insoluble gel. The product $Rn\rho$, where n is the number of carbons per atom, and ρ the density, is approximately constant from heptane ($n = 7$) to Polythene ($n \sim 2000$), although an anomaly may occur for Winnothene ($n \sim 250$). This indicates that the energy required to form a cross-link is approximately independent of chain length. An analysis of published experiments on methane and butane extends this conclusion down to $n = 1$. The results obtained by earlier workers when paraffinic gases are bombarded with deuterons and α-particles are explained in terms of the cross-linking phenomenon. Solubility measurements give similar values for $Rn\rho$ in the case of Polythene and Winnothene, and show that for every cross-link formed, on the average about 0·35 C—C bonds in the main chain are

fractured. Similar values are obtained for methane and butane. The energy absorbed per C—H bond fracture is about 12 eV, and the energy per cross-link is 24 eV. This corresponds to 0·5% of carbons becoming cross-linked per unit radiation, independent of the physical state (solid, liquid or gaseous) of the irradiated paraffin. The importance of these results, as far as polymerization theory is concerned, is briefly discussed. A.

541.15

3960. Irradiation of ferrous ammonium sulfate solutions: energy absorption and ionization calculations for cobalt 60 and betatron radiation. D. V. Cormack, R. W. Hummel, H. E. Johns and J. W. T. Spinks. *J. chem. Phys.*, **22**, 6–12 (*Jan.*, 1954).

Solutions of ferrous ammonium sulphate in 0·8N H_2SO_4 were irradiated with Co^{60} γ-rays and with X-rays from a 25-MeV betatron. The energy absorbed per unit volume of solution has been calculated from a modification of the Bragg–Gray formula, $E_v = J_v W \rho$ in which the factor ρ was determined according to a calculated distribution of primary electron energies. The chemical yield was then calculated in terms of G, the number of ferrous ions oxidized per 100 eV absorbed. A.

541.15

3961. Radiation-induced reaction between iodine and [*n*-] heptane. P. F. Forsyth, E. N. Weber and R. H. Schuler. *J. chem. Phys.*, **22**, 66–70 (*Jan.*, 1954).

This was studied with a view to its use in the quantitative determination of free radical production in the radiolysis of liquid hydrocarbons. The yield of this reaction has been found to be nearly independent of iodine concentration and of temperature of the sample. The reaction is inhibited by the presence of dissolved oxygen. For each mole of hydrogen produced, 0·6 mole of iodine is absorbed which indicates that free radical production is a major component of the over-all process. The primary decomposition yield is of the order of 10 bonds broken per 100 eV of absorbed energy. A.

541.15 : 534.321.9

Elucidation of the chemical effects of ultrasonics. *See Abstr.* 3228

541.15 : 537.531

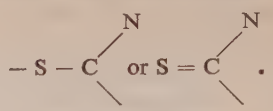
3962. Comments on the mechanism of X-ray chemical oxidations in aqueous solution. E. Abel. *Z. phys. Chem.*, **202**, 108–16 (*July*, 1953) *In German.*

An attempt is made, on theoretical grounds, to establish a mechanism for the effects of X-rays on aqueous solutions of ferrous and ferric salts in the presence and absence of oxygen alternative to that put forward by Rigg, Stein and Weiss [Abstr. 3081 (1952)]. C. B. ALLSOPP

541.15 : 539.166

3963. Action of protecting agents on γ-ray degradation of polymer solutions. M. Fox. *C.R. Acad. Sci. [Paris]* **237**, 1682–4 (*Dec.* 21, 1953) *In French.*

The protecting effect of various agents on dilute chloroform solutions of polystyrene is followed by means of viscosity measurements before and after irradiation with Co^{60} γ-rays (source = 27 curies; 30 000 r produces 27–30% change in time of flow through an Ostwald-type viscosimeter). Their protecting efficiency is much the same in chloroform as in water, except for allyl compounds, which work better in water. Two groups of agents can be distinguished: (*a*) compounds containing mobile H-atoms (e.g. phenols and some amines): –SH compounds are less active than would be expected; (*b*) organic compounds with the structure



Group (*a*) protects mainly against after-effects of irradiation: there is no after-effect when irradiation is made in presence of group (*b*) compounds. A table of experimental observations is given. C. B. ALLSOPP

DISPERSIONS . COLLOIDS ADSORPTION 541.18

541.182.2

3964. Steady-state diffusion into a streaming sphere at low Reynolds number. H. L. Frisch. *J. chem. Phys.*, **22**, 123–5 (*Jan.*, 1954).

A solution of the steady-state Smoluchowski equation, describing diffusion into a spherical sink streaming with constant velocity relative to the fluid, is obtained as a power series in a parameter which is directly proportional to the Reynolds number of the flow. For small values of Reynolds number the series converges. The concentration and flux to a freely falling cloud droplet (aerosol particle) in air is calculated. The effect of the motion of the droplet on the flux is proportional to a first approximation to the square of Reynolds number and consequently except for very large times of observation exerts a negligible influence on the diffusion controlled growth of the droplet. An extension of the method to non-stationary diffusion problems is indicated. A.

541.182.3

3965. Diffusional processes in the growth of aerosol particles. II. H. L. Frisch and F. C. Collins. *J. chem. Phys.*, **21**, 2158–65 (*Dec.*, 1953).

For Pt I, see Abstr. 1225 (1953). The effect of the moving boundary of the growing aerosol particle upon the diffusional processes previously investigated for the special case of sinks with stationary boundaries is now discussed in detail. The zeroth-order approximation for the flux rate, valid for aerosol and most colloid systems, is found to be of the same analytic form as that for the stationary boundary case. A growth equation is derived for particles growing in the presence of a plurality of competing sinks which deplete the supersaturation. The growth equation here derived is found to be in satisfactory agreement with experiment in the case of barium sulphate crystals growing in aqueous solution. It is further shown that self-nucleated sols tend to monodispersity with growth. The effects of additional molecules becoming available for diffusion and of variability of the absorption probability are also discussed and evaluated for the special case of a single particle in the diffusion field. A.

541.183 : 541.123.5

56. Ion-exchange and adsorption column kinetics h uniform partial presaturation. T. VERMEULEN AND K. HIESTER. *J. chem. Phys.*, **22**, 96–101 (*Jan.*, 54).

The available mathematical solutions for fixed-bed ncentration histories apply primarily to one-com- nent systems in adsorption and to two-component stems in ion exchange. Thomas has developed plicit general relations for the saturation of an sorbent bed initially free of saturating component a fluid phase containing only this component; as ll as for the converse elution situation. These sults are extended here to cases of mixed binary feeds n ion exchange), and cases of columns that are niformly partially saturated prior to the run under udy. New definitions of the dimensionless para- eters that characterize the sorption processes render e existing numerical framework applicable for valuating this broadened range of operating condi- ons. From the theoretical standpoint, these new arameters clarify the mathematical inter-relationships etween adsorption and ion exchange, between turation and elution and between sorption of trace mponents and sorption of gross or bulk components. method is suggested for calculating physical-adsorp- on operations which do not conform to Langmuir otherms. Calculation procedures based upon this pproach are illustrated by an idealized but repre- ntative example. A.

CHEMICAL STRUCTURE 541.2/.6

541.5 : 539.132

Theory of the chemical bond. *See Abstr.* 3735

541.57

967. On the binding of Fe_2Al_5 and $MnAl_6$. K. CHUBERT AND M. KLUGE. Note in *Z. Naturforsch.*, a, 755–6 (*Nov.*, 1953) *In German.*

The chemical binding in Fe_2Al_5 is similar to that n $CuAl_2$. The outer electrons show strong space orrelation, and may be assumed to lie on 72 positions n the unit cell. Of these 8 lie close to certain of the Al atoms and are discarded leaving 64 places to be illed by the 62 electrons (Fe–8 electrons, Al–3). A imilar discussion is carried out for $MnAl_6$.

W. M. LOMER

LABORATORY APPARATUS 542.1/.7

542.48

968. Preparation of high-purity lithium metal by vacuum distillation. P. S. BAKER, F. R. DUNCAN AND H. B. GREENE. *Science*, **118**, 778–80 (*Dec.* 25, 1953).

Illustrated description of an apparatus for small- cale purification of Li by vacuum distillation, made of stainless steel and Pyrex glass (or "black" iron). The temperature of distillation is ~500°C. Typical lata showing the efficiency of the process are tabu- ated. When Sr as an impurity is absent, a 5 g charge of Li with 2–3% impurities yields in ~4 hours 60–70% of the charge in the form of 99·5%+ metal when the pressure is 0·05 μ. F. LACHMAN

542.73

3969. A reciprocating mercury pump for gas analysis apparatus. E. A. C. CHAMBERLAIN, S. R. M. DIXON AND P. L. WATERS. *J. sci. Instrum.*, **31**, 66–7 (*Feb.*, 1954).

A reciprocating mercury pump which is used to mechanize the Haldane type of gas analysis apparatus is described. This pump unit, being simple and robust in construction, has proved reliable for continuous routine use. A.

CHEMICAL PROCESSES 542.9

542.9

3970. Corrosion tests for liquid metals, fused salts at high temperatures. D. C. VREELAND, E. E. HOFFMAN AND W. D. MANLY. *Nucleonics*, **11**, 36–9 (*Nov.*, 1953).

Experimental methods used in determining the reactions that take place between hot liquid metals or fused salts and various structural metals are described. Both static tests, in which the molten salt or metal is at rest with respect to the specimen, and dynamic tests with the liquid moving at various speeds over the specimen, are included.

L. R. SHEPHERD

CHEMICAL ANALYSIS 543/545

545.37

3971. The construction of a renewed mercury cathode of constant surface. M.-P. SIMONNIN AND M. QUINTIN. *C.R. Acad. Sci.* [*Paris*] **237**, 1409–11 (*Nov.* 30, 1953) *In French.*

In electrical polarography the mercury cathode has a variable surface with resultant disadvantages, and a cathode of constant surface and of well-defined polarization is now described. It consists of a column of Hg in a semicapillary tube, whose surface is renewed by the fall of drops of Hg from a capillary. The variable voltage is applied between this constant surface and a non-polarizable electrode (Ag/AgCl) inserted directly in the solution examined. This solution also contains an indifferent (KCl) and a much more dilute electroreducible electrolyte. Nitrogen is bubbled through the solution to remove dissolved oxygen. Reproducible current-voltage curves are obtained. H. H. HODGSON

545.7

3972. A variant of a thermoconductimetric method of analysis of gaseous systems. W. MUND, M. VAN MEERSSCHE AND C. GUIDÉE. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 8–9, 676–83 (1953) *In French.*

Describes an apparatus involving simultaneous use of 3 cells, and ensuring a better accuracy in the analysis of gaseous mixtures by measuring their thermal conductivity. Each Pyrex-glass cell is ~12 cm long and 6 mm inner dia., with a centrally placed Pt heating wire 0·04 mm thick. The method is described in detail, and the results of the analysis of H_2–He mixtures are tabulated. F. LACHMAN

545.721 : 538.65

3973. Oxygen measurement on a magnetic basis with strong suppression of the zero point. E. Ebbinghaus. *Z. angew. Phys.*, **5**, *No.* 8, 294–7 (1953) *In German.*

Modifications to an oxygen meter, dependent upon the cooling of a heated filament when the surrounding gas is subjected to an inhomogeneous magnetic field, are described. By alteration of the inclination of the measuring tube dynamic compensation of the "magnetic wind" may be obtained and the range of operation restricted with a gain in sensitivity. In this way an accuracy of 0·01% has been attained in the concentration range 20–21% oxygen. F. E. HOARE

545.82

3974. Optical method for the measurement of small amounts of oxygen in a helium atmosphere. J. W. Moyer and W. A. Ruggles. Letter in *J. Opt. Soc. Amer.*, **44**, 86–7 (*Jan.*, 1954).

The helium sample with its oxygen impurity is allowed to circulate over a freshly prepared sodium surface which reacts with any oxygen present. The thickness of the oxide film so formed is measured by the change in the phase difference introduced into a monochromatic beam of light reflected at the sodium surface. Using a 10 cm² surface a minimum of four to five microlitres of oxygen could be detected. Suitably reflecting sodium surfaces were prepared by quickly cooling a pool of molten sodium to liquid nitrogen temperature. D. G. AVERY

545.822

3975. Calculation of integrated intensities in spectrographic microanalysis. J. K. Hurwitz. *J. Opt. Soc. Amer.*, **44**, 30–4 (*Jan.*, 1954).

The change in integrated intensity occurring when a spark traverse is made across a region in which a very high concentration gradient exists has been calculated. The theory which was developed accounted for the effect of sparked-volume size, spectrograph and microphotometer slit-lengths, and the ratio of the camera speed to the sample speed. Three separate assumptions regarding the shape of the sparked volume were made, viz. a circular disk of uniform thickness, a cap of a sphere, and a paraboloid of revolution. The disk gave good agreement only if the sample speed was sufficiently high: at lower speeds this was not true since the spark discharge remained upon one point long enough to etch out a crater of microscopically observable size. The latter two shapes were satisfactory for all practical conditions. It is suggested that this theory may be extended to the analysis of segregates in metals and alloys even though the segregate may be considerably smaller than the sparked volume. A.

545.827

3976. Analysis of radionuclide mixtures. R. E. Connally and M. B. Leboeuf. *Analyt. Chem.*, **25**, 1095–100 (*July*, 1953).

β and γ scintillation detectors have been designed for use with an automatic-recording energy spectrometer. The application of this instrument to the analysis of mixtures of radio-nuclides which decay by γ-emission has been investigated. Integration of the area under the photoelectric peak of a differential pulse height scan obtained with the γ-energy spectrometer permits quantitative determination of each γ-emitter present. Using this instrument, the γ-activities present in solutions containing three γ-emitters have been identified, and the individual γ-activities have been determined with an average precision of $\pm 7\%$ (95% confidence limits) for triplicate determinations over concentrations of 10 to 70% of total γ-activity. Analysis of solutions containing mixed γ-emitters were performed directly, without preliminary separations, in less than 40 minutes. A.

545.827

3977. Use of a scintillation spectrometer in radiochemical analysis. B. Kahn and W. S. Lyon. *Nucleonics*, **11**, 61–3 (*Nov.*, 1953).

A scintillation spectrometer using a NaI(Tl) crystal is described. The instrument can be used to identify and estimate the amounts of particular radio isotopes present in active samples. L. R. SHEPHERD

545.827

3978. Possibility of the microdetermination of carbon in organic compounds by the nuclear reaction $_6C^{12}(d, n)_7N^{13}$. P. Süe. *C.R. Acad. Sci.* [*Paris*] **237**, 1696–8 (*Dec.* 21, 1953) *In French.*

Results of some experiments in which certain organic compounds were irradiated and measured in silica micro-tubes seem to point to the possibility of micro-determination of C in these compounds by the direct measurement of the activity of radio-nitrogen. F. LACHMAN

545.84 : 535.39

3979. Determination of concentration and absorption coefficients of adsorbates by reflection measurements. G. Schwuttke. *Z. angew. Phys.*, **5**, *No.* 8, 303–6 (1953) *In German.*

Measurements are made in the wavelength region 3000–4000 Å of the reflections (R) of a layer of powder on which flavazine, flavianic acid, etc., have been adsorbed. The function $(R-1)^2/2R$ should be proportional to concentration and specific extinction coefficient (ε). This expectation is fulfilled except for small values of ε near absorption minima. It is hoped to use the method for determining concentrations of chromatographic adsorbates. G. F. LOTHIAN

CRYSTALLOGRAPHY 548

548.0 : 535 : 537

3980. On the optical and electrical properties of single crystals of cadmium sulphide. H. Gobrecht and A. Bartschat. *Z. Phys.*, **136**, *No.* 2, 224–33 (1953) *In German.*

It is shown by measurements on single crystals of CdS that the lattice absorption edge must be at wavelengths less than 5025 Å. Measurements with polarized light show that the edge position is dependent on the relation between polarization angle and

stal axes. This is verified by photocurrent response asurements. Piezoelectric properties are also estigated. G. F. J. GARLICK

548.1 : 512.9

The number of independent components of tensors n symmetrical systems. *See Abstr.* 3010

548.1 : 539.32 : 537.228.1

Elastic constants and piezoelectric crystals. *See str.* 3456

548.5

81. Growth spirals on crystals of long chain mpounds. S. AMELINCKX. Note in *Naturwissenhaften*, **40**, *No.* 24, 620–1 (1953).

Observations on crystals, crystallized from benzene, a series of monocarboxylic acids and *n*-alcohols ntaining even numbers of carbon atoms ranging om 16 to 26 are briefly reported. Growth spirals the Frank type were observed, and a double spiral a lignoceric acid [$CH_3(CH_2)_{22}COOH$] crystal, a mple spiral on an alcohol ($C_{26}H_{53}OH$) crystal, two irals of opposite sign generating closed terraces, and e mutual annihilation, due to movement, of two slocations of opposite sign on behenic acid $H_3(CH_2)_{20}COOH$] crystals, are illustrated. The iral shapes of the acids and paraffins are the same, t differ from that of the alcohols in which strong isotropy in the growth velocity is indicated. Crossed growth spirals give strong evidence of polytypism the alcohols. S. WEINTROUB

548.5

982. Spiroidal crystals of zinc sulphide. W. L. OTH. Letter in *Nature* [*London*] **173**, 38–9 (*Jan.* 2, 954).

A new type of crystal form, for which the term spiroid" is used to convey the topological character f the habit, is reported in zinc sulphide crystals rown by sublimation. Two typical spiroids are lustrated. They are hexagonal zinc sulphide, but isordered with a high density of stacking faults ormal to the basal planes. The spiroid axis is 11·0]. The crystallography of the forms was tablished by X-ray and microscope techniques. A ypothesis in terms of edge dislocations to account or the departure from the normal habit of hexagonal inc sulphide is advanced. S. WEINTROUB

548.5

983. Note on the crystallization of stilbene from olutions. E. J. MILER. *Bull. Inst. Nuclear Sci. Boris Kidrich*," **3**, 119–20 (*Aug.*, 1953).

The seeded crystals are crystallized from ether by he successive evaporation of the solvent. The growth s slow, but samples of regular geometrical shape are btained. S. WEINTROUB

548.5

984. Oriented overgrowth of primary oxide on α-Fe. R. SATO. *J. Phys. Soc. Japan*, **8**, 758–61 (*Nov.–Dec.*, 953).

Electron diffraction investigation of the primary xide of iron (γ-Fe_2O_3 or Fe_3O_4) produced on the α-Fe layer, which was deposited on oxidized zinc-lende cleavage face by evaporation, showed that the rientation of the oxide with respect to α-Fe was: $\{100\}_{oxide}//\{100\}_{Fe}$, $\langle 110\rangle_{oxide}//\langle 100\rangle_{Fe}$. A.

548.5

3985. Microscopic studies on deformed ZnS-crystals. E. VOTAVA, S. AMELINCKX AND W. DEKEYSER. *Physica*, **19**, 1163–72 (*Dec.*, 1953).

An optical and interferometric study was made of (111) faces of ZnS crystals grown at relatively high temperature. In addition to triangular growth terraces and incompletely developed growth spirals, an extensive substructure, covering the whole of the faces, was found. This substructure was proved by multiple beam interferometry to consist of steps. Evidence for movement of dislocations is also given. The substructure itself is divided into a fine-structure by lines of lower visibility, some of which are rows of etchpits. They are interpreted as polygonization lines (rows of Taylor dislocations), or very small steps. A.

548.5 : 536.7

3986. Thermodynamics of the crystal nuclei. R. KAISHEV. *Izv. Bulg. Akad. Nauk*, **2**, 191–204 (1951) *In Bulgarian.*

The thermodynamics of the crystal formation from supersaturated phases is discussed, based on a derivation of Wulff's rule of the equilibrium form of crystals in a homogeneous phase, by a thermodynamical method, where the energy required for an isothermal-reversible formation of crystals is determined as a function of crystal size and degree of supersaturation. Furthermore, a generalized form of the Wulff rule is derived for crystal faces contiguous with other phases, again yielding an equilibrium form. In the latter there is such a point that the distances separating it from the free crystal faces are proportional to the corresponding surface energies, whereas the distances to faces contiguous with foreign phases are proportional to the differences between the corresponding surface energies and the specific energies of adhesion. The work to be done on isothermal-reversible formation of crystals as a function of crystal size and supersaturation is determined; the ratio between the work on formation of a crystal nucleus in the homogeneous-supersaturated phase and the nucleation work on a foreign carrier (basis) equals the ratio of the corresponding nuclear volumes at the supersaturation concerned. Lastly, the relation between thermodynamics and the Stranski–Kaishev method for calculating the equilibrium form of crystals and for determining the conditions of equilibrium between a crystal and its surroundings is considered. B. F. KRAUS

548.52 : 541.135

On the theory of electrolytic crystal growth. *See Abstr.* 3951

548.53

3987. "Memory" in crystals of quartz. E. V. TSINZERLING. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 5, 785–6 (1953) *In Russian.*

If certain BT-cut quartz plates, twinned according to the Dauphiné law, are untwinned by deformation by twisting, heated to 600° and cooled, that is, taken through the $\beta \rightarrow \alpha \rightarrow \beta$ transformations, then a twinning pattern, laterally transposed with respect to the original, appears. Repetition of the cycle can restore the original state. The phenomenon appears

to be connected with the presence of a large number of minute inclusions. A. L. MACKAY

548.535

3988. On the mechanism of grain growth in metals, with special reference to steel. D. G. COLE, P. FELTHAM AND E. GILLAM. *Proc. Phys. Soc.* [*London*] *B*, **67**, 131–7 (*Feb.*, 1954).

The rate of grain growth in the initial stages of isothermal austenitizing was studied by a thermal etching method in plain, eutectoid, carbon steel in the range 840–970°C. An equation relating the mean initial and instantaneous grain diameters, D_0 and D, to the austenitizing time t, of the form $D^2 - D_0^2 = Kt \exp(-H/kT)$ is developed on the assumption that the growth rate is controlled by interfacial tension at grain boundaries. An estimate of the constant K is made, and by the use of experimentally obtained values of D, D_0 and t the value of H is calculated to be 30 kcal/g atom, close to the activation energy estimated for grain-boundary self-diffusion and to that determined for the damping of low-amplitude torsional oscillations. A.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7 : 530.162

3989. Statistical mechanics of two dimensional lattice. I. SYOZI. *Annu. Rep. sci. Works Fac. Sci. Osaka Univ.*, **1**, 1–18 (1952).

Short review of a simplified matrix treatment of the rectangular Ising model with two-step periodically alternating bonds. 13 refs. F. ANSBACHER

548.7

3990. The determination of the amplitude of thermal motion of ions in crystals in terms of measured structure factors. U. KORHONEN. *Ann. Acad. Sci. Fennicae, A1, No.* 152, 10 *pp.* (1953) *In German.*

Theoretical. A formula is given for calculating the effective scattering factor of any one ion from the measured structure factors of the crystal: from this, the amplitude of vibration of that ion can be obtained. A. R. STOKES

548.7 : 536.77

Tables of thermodynamic functions for chain and layer structures. *See Abstr.* 3412

548.7 : 537.226.1

Clausius–Mosotti equation for certain types of anisotropic crystals. *See Abstr.* 3442

548.7 : 537.226.3

Theory of dielectric relaxation. *See Abstr.* 3454

548.7 : 537.312.62

On a correlation between the electron assembly and the lattice waves in the crystal. *See Abstr.* 3501

548.7 : 537.533.9

3991. Some ordering effects in Cu_3Au at about 100°C. R. A. DUGDALE AND A. GREEN. *Phil. Mag.*, **45**, 163–72 (*Feb.*, 1954).

Using the electrical resistance as an indicator for ordering it is found that Cu_3Au specimens prepared in a state of long-range order and then water-quenched from 380°C (8°C below the critical temperature) show an ordering effect at about 100°C. After this has decayed a similar effect is again observed after an electron bombardment (energies of 0·5 and 1 MeV) or after a small deformation at room temperature. An activation energy $E \sim 0{\cdot}9$ eV for all three cases is determined. Attributing the ordering effect to the migration of vacancies or interstitials the experiments provide evidence that one or both of these defects are obtained in thermodynamic excess by quenching or deforming. A

548.

3992. Density and disorder in AgBr crystals with admixtures. H. JUNGHANSS AND H. STAUDE. *Z. Elektrochem.*, **57**, 391–3 (*June*, 1953) *In German.*

Density determinations of high precision have shown that Schottky type disorder, viz. cation holes in an unchanged anion lattice, occurs in AgBr single crystals with an admixture of $CdBr_2$. F. LACHMA

548

3993. The theory of defect concentration in crystals. G. H. VINEYARD AND G. J. DIENES. *Phys. Rev.* **93**, 265–8 (*Jan.* 15, 1954).

The theory of the formation of vacancy and interstitial defects in crystals is re-examined. It is suggested that a Born–von Karman type of lattice provides an adequate model for the calculation of the essential parameters giving the concentration of defects as a function of temperature. It is concluded that the entropy of formation depends only on the lattice frequencies before and after formation of the defect, and no further contribution to the entropy arises even though the enthalpy of formation may appear to remain temperature dependent at constant pressure. Data on vacancy concentration in NaCl and LiF are analysed roughly in the light of present ideas. The results for NaCl are understandable in a simple way; those for LiF seem to require more complete calculations. A

548.7 : 541.128

The question of the interdependence of the conditions of the crystal lattice of a catalyst and its activity. *See Abstr.* 3942

548.7 : 535.376

3994. Nature of activators in quartz. H. E. VEDENEEVA AND L. G. CHENTSOVA. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 2, 197–200 (1952) *In Russian.*

Quartz under short-wave irradiation is coloured and shows thermo- and cathodo-luminescence. After passage of current the anode layer loses colour. A photograph in transmitted light shows that the section of the discolour-cleared part takes the form of the anode. A photograph by its own luminescent light shows that only the darkened part is luminescent. Experiment shows that colour and luminescent centres are either closely allied or identical. Assuming activators are either Mn or Fe, calculation of the charge moved during the passage of current agrees with the calculated weight of impurity ions in the cleared layer. The current falls from 2–10 mA at the beginning to 10–50 μA at the end. Plotting the current at the end against $1/T$, a straight line is obtained giving the energy of binding as 1·27 eV

hich is compared with 0·78 eV obtained by Harris d Waring for Li ions [*J. phys. Chem.*, **41**, 1077 937)]. The motion of the cleared area is along the axis. J. EWLES

548.7 : 535.343.2

995. Features of spectra of smoky quartz as dications of the structure of its colour centres. H. E. EDENEEVA AND E. S. RUDNITSKAYA. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 3, 361–4 (1952) *In Russian.*

Absorption in polarized light of 3 different samples om 3 different parts of Russia obtained in different ates of samples (natural state, decoloured and tificially coloured) was investigated, both before and ter heat treatment. All show a maximum at about 400 Å and differences in dichroism. Only the traordinary-ray absorption spectra are affected y heat treatment. An attempt is made to correlate sults with the idea of a centre consisting of a reign ion in a "structural canal" distorting the ttice in a symmetrical region round the canal ccupying some 10^3 to 10^5 unit cells. J. EWLES

548.7

996. Mechanism of additive coloration of alkali alide crystals. L. M. SHAMOVSKIĬ, L. I. RŸBAKOVA ND M. I. GOSTEVA. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 1, 67–70 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-82.

It is shown that not only the position and shape of he *F*-band but also the limiting density of coloration s independent of the alkali metal vapour used if the atter is always saturated. The coloration is found o be an irreversible process. Experimental facts how that no new vacant anion sites are formed luring coloration but electrons are added to form -centres. Bleaching of additively coloured crystals y heating KCl in Cd vapour is explained by removal f electrons and a corresponding number of cations, iving rise to Shottky defects in the lattice.

G. F. J. GARLICK

548.7

997. Formation of *V*-centres in alkali halide rystals during their additive coloration in halogen apours. L. M. SHAMOVSKIĬ. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 2, 229–32 (1953) *In Russian.* English ranslation, *U.S. National Sci. Found. NSF-tr*-98.

Ultraviolet absorption bands due to additive coloration of alkali halides by halogens are correlated with the *V*-band produced by X-ray irradiation. A weaker, longer-wavelength band is attributed to halogen molecules on atoms at internal flaw surfaces. A critical discussion of Mollwo's theory of additive coloration is given. G. F. J. GARLICK

548.7

998. Colour bands in fluorspar. K. PRZIBRAM. Letter in *Nature* [*London*] **172**, 860 (*Nov.* 7, 1953).

548.7 : 535.343.2

999. Iodide impurity absorption in potassium and sodium bromides. C. J. DELBECQ, J. E. ROBINSON AND P. H. YUSTER. *Phys. Rev.*, **93**, 262–3 (*Jan.* 15, 1954).

Optical absorption bands due to a dilute iodide ion impurity in KBr and NaBr are reported. Experimental data show, and semiquantitative theoretical arguments are given, which indicate that the displacement of the iodide impurity absorption from the absorption of the bromide lattice is approximately equal to the difference in the electron affinities of iodine and bromine. A.

548.7 : 535.343.2

4000. A study of the $F \rightarrow Z_1$ conversion in KCl crystals with divalent impurities. P. CAMAGNI AND G. CHIAROTTI. *Nuovo Cimento*, **11**, 1–10 (*Jan.*, 1954).

The $F \rightarrow Z_1$ conversion under the action of *F* light is studied in KCl crystals containing a small amount of Sr ($5 \cdot 5 \times 10^{-5}$ molar fraction), which were coloured either additively or by X-irradiation. The quantum yield of the conversion during the exposure to *F* light was determined. The assumption is made that only the Sr^{++} ions which are not associated with a positive ion vacancy are responsible for the formation of Z_1 centres. The general behaviour of the quantum yield during the conversion allows one to determine the ratio of the capture cross-sections for electrons of the negative ion vacancies and divalent ions, and the number of negative ion vacancies present in the crystal. The values are, respectively, $\sigma_F/\sigma_{Z_1} = \sim 1$ and $N_v = \sim 1 \cdot 4 \times 10^{17}/\text{cm}^3$. With the same hypothesis the association energy of the complex Sr^{++}-positive ion vacancy can be determined, which is about 0·3 eV. The value of the oscillator strength of the Z_1 centre is also found, the value being 0·84. The values so obtained for the capture cross-sections, the association energy and the oscillator strength appear entirely reasonable. A.

548.73/.74

4001. Recent Soviet work in the field of crystallography. A. L. MACKAY. *Nuovo Cimento*, **10**, *Suppl. No.* 4, 387–414 (1953).

Consists of a very lengthy bibliography (307 refs.), with a commentary on the items included, and a short summary of the contents of two or three of the outstanding papers. The entries are confined (except in the case of work in unfamiliar publications) to papers published during and after 1950, omitting papers covered by *Structure Reports*. The subjects are divided as follows: Symmetry and structure determination theory (33 refs.); structures (60 refs.); instruments, apparatus and practical techniques (21 refs.); electronography (23 refs.); crystal physics (41 refs.); crystal chemistry (19 refs.); growth and textures (49 refs.); metals (45 refs.).

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 3907–8, 3911–13

548.732 : 534.21

4002. The Bragg method demonstrated with sound waves. G. BARNES. *Amer. J. Phys.*, **21**, 688–9 (*Dec. I*, 1953).

548.733

4003. A low-temperature X-ray camera. E. A. OWEN AND G. I. WILLIAMS. *J. sci. Instrum.*, **31**, 49–54 (*Feb.*, 1954).

Describes a camera suitable for the examination of small plates. The specimen under examination is cooled in a stream of air for temperatures in the range between room temperature and −170°c, and by dropping liquid air on it for the lowest temperature reached (−194°c). Temperatures were measured

directly with a copper-constantan thermocouple for single specimens or by reference to the lattice parameter of a standard material for double specimens. These temperatures were taken whilst the specimens were being simultaneously rotated and oscillated. The results obtained with silver and iron are quoted. The coefficients in the expansion equation $a_t = a_0(1 + \alpha t + \beta t^2 + \gamma t^3)$ for these metals were found to be as follows: Silver: $\alpha = 18{\cdot}2606 \times 10^{-6}$, $\beta = 3{\cdot}9156 \times 10^{-9}$, $\gamma = -17{\cdot}2794 \times 10^{-12}$, and a_0, the lattice parameter at 0°c, is $4{\cdot}0760kx$; Iron: $\alpha = 11{\cdot}9784 \times 10^{-6}$, $\beta = 15{\cdot}8447 \times 10^{-9}$, $\gamma = -3{\cdot}2973 \times 10^{-12}$, $a_0 = 2{\cdot}8598kx$. A.

548.733

4004. A simple X-ray diffraction vacuum camera for measuring long spacings. D. C. BISSET AND J. IBALL. *J. sci. Instrum.*, **31**, 55–6 (*Feb.*, 1954).

A camera is described for measuring long spacings (Bragg angles less than 2°). The camera is calibrated by making use of built-up multilayers of barium stearate and octadecylamine. A.

548.733

4005. The use of multiple films for measuring intensities of X-ray diffraction spots. J. IBALL. Letter in *J. sci. Instrum.*, **31**, 71 (*Feb.*, 1954).

In order to relate the intensities of strong reflections to those of weak ones, a pack of two, or three, films of different sensitivities are used. With an Ilford "G" type X-ray film placed in front of an Ilford "B" film an intensity ratio of 8 : 1 is obtained, compared with a ratio of approximately 2 : 1 if two films of the same sensitivity are used. J. IBALL

548.734

4006. Pressure effects on the measurement of lattice parameter. C. R. BERRY, M. H. VAN HORN AND R. L. GRIFFITH. Letter in *Acta cryst.*, **7**, 135 (*Jan.*, 1954).

Silver bromide grains dispersed in gelatine coated on glass show contractions of lattice parameter up to 0·3% when the relative humidity is changed from 100% to 40%. It is shown that these changes can be attributed to stresses set up in the gelatine.

A. R. STOKES

548.735

4007. Intensity of X-ray diffraction by a one-dimensionally disordered crystal. I. General derivation in cases of the "Reichweite" $S = 0$ and 1. J. KAKINOKI AND Y. KOMURA. *J. Inst. Polytech. Osaka City Univ. B*, **2**, 1–9 (*Oct.*, 1951).

A random sequence of layers is considered, and the intensity of diffraction is calculated by a matrix method developed from that of Hendricks and Teller [*J. chem. Phys.*, **10**, 147–67 (1942)]. If the "Reichweite" $= S$, then the probability distribution of the nth layer is a function only of the $(n-1)$th ... $(n-S)$th layers; thus when $S = 0$ every layer is independent of its neighbours. The intensity of diffraction is derived in terms of a matrix whose terms are products of form factors of the layers and a matrix whose terms are probabilities of the various layers appearing. The results are compared with those of Wilson [*Proc. Roy. Soc. A*, **180**, 277–85 (1942)] and Jagodzinski [Abstr. 6563–4 (1949), 3525 (1950)]. The case of a crystal with a small number of layers is also considered. A. R. STOKES

548.73

4008. Intensity of X-ray diffraction by a one-dimen sionally disordered crystal. II. General derivation i case of the "Reichweite" $S \geqslant 2$. J. KAKINOKI AN Y. KOMURA. *J. Inst. Polytech. Osaka City Univ. E* **3**, 1–33 (*Oct.*, 1952).

The matrix expression obtained for $S = 0$ an $S = 1$ is shown to be valid for any value of $S \geqslant 2$ the elements of the matrices are properly chosen. simple example with $S = 2$ is worked out.

A. R. STOKE

548.73

4009. Intensity of X-ray diffraction by a one dimensionally disordered crystal. III. The clos packed structure. J. KAKINOKI AND Y. KOMURA *J. Inst. Polytech. Osaka City Univ. B*, **3**, 35–51 (*Oct* 1952).

The case of close-packed layers which can follo each other either in hexagonal or cubic packing considered. The results are shown to agree with thos of Wilson, Hendricks and Teller, and Jagodzinsk (for refs. see Pt I). A. R. STOKE

548.73

4010. Simplified methods of calculating the kine matic factor. E. N. BELOVA AND N. V. BELOV. *Dok Akad. Nauk SSSR*, **90**, *No.* 2, 183–4 (1953) *I Russian.*

Increasing use of three-dimensional syntheses ha made the calculation of Lorentz-polarization factor very laborious. A nomogram is given for calculatin $\left[1 - \left(\frac{\sin\mu}{\sin 2\theta}\right)^2\right]^{\frac{1}{2}}$ from θ and μ (altitude of laye line). The remaining part of the factor, $(1 + \cos^2 2\theta)/2 \sin 2\theta$, depends only on θ. A. L. MACKA

548.73

4011. A scale for calculating interplanar spacing and indexing X-ray powder photographs. B. K VAĬNSHTEĬN. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 5 777–80 (1953) *In Russian.*

Slide rules graduated in reciprocal squares are use for calculating d_{hkl} in the form $1/d^2_{hkl} = h^2/a^2 + k^2/b^2 + l^2/c^2$. By the addition of a cross-ter $-2hl \cos\beta/ac \sin^2\beta$ and the multiplication of a^2 an c^2 by $\sin^2\beta$ the monoclinic system can also be deal with. Scales for f, θ and the Lorentz-polarizatio factor can also be provided. The indexing of photograph from orthorhombic $BaSO_4$ is described.

A. L. MACKA

548.735 : 518.5 : 621.317.7

4012. Electrical machine for making some calcula tions occurring in determination of crystal structures J. MONTES VILLALÓN AND M. ABBAD. *An. Real. Soc Españ. Fís. Quím.*, **49**(A), 173–80 (*May–June*, 1953) *I Spanish.*

The machine is designed for evaluation of the expres sion $nf\{\sin/\cos\}2\pi(h_1x_1 + k_1y_1 + l_1z_1)\{\sin/\cos\}2\pi(h_2x + k_2y_2 + l_2z_2)\{\sin/\cos\}2\pi(h_3x_3 + k_3y_3 + l_3z_3)$. The elementary circuit consists of 2 balanced Wheatstone bridges $R_{11}R_{12}R_{13}R_{14}$ and $R_{21}R_{22}R_{23}R_{24}$ in which $R_{12} = R_{21}$ and thus $R_{22} = R_{11}R_{14}R_{24}/R_{13}R_{23}$. Taking $R_{11} = r_1 \sin\theta_1$, $R_{14} = r_1 \sin\theta_2$, $R_{13} = r_1 \operatorname{cosec}\theta_3$ $R_{22} = r_2u$, $R_{24} = r_3f$, $R_{23} = r_4n$ and $r_1r_3/r_2r_4 = 1$, the value of $u = nf \sin\theta_1 \sin\theta_2 \sin\theta_3$ is of the desired

m. The circuits for manipulating the bridges, for luating the angles θ from observed values of k, l, x, y, z and the final arrangement of switches l resistors, are shown and the action is explained.
J. A. WILCKEN (R)

548.735.4

13. The signs of products of structure factors. W. HUGHES. Letter in *Acta cryst.*, **6**, 871 (*Nov.*, 53).

A simple proof is given that the mean value of $U_H.U_K$, for constant $\mathbf{H}+\mathbf{K}$, has the same sign as U_{H+K}, for a centrosymmetric crystal. The conclusion that $U_H.U_K$ is likely to have the same sign as U_{H+K} is tested on some experimental data and found to hold.
A. R. STOKES

548.735.4

14. A generalization of the Patterson function. W. HUGHES. Letter in *Acta cryst.*, **6**, 872 (*Nov.*, 53).

By using probability relations between the sign of structure factors (preceding abstract) one can construct a modified Patterson function of a centrosymmetric structure in which (ideally) only the peaks due to vectors between pairs of atoms related by the centre of symmetry are prominent; thus the Patterson synthesis becomes a double-sized Fourier synthesis of the structure.
A. R. STOKES

548.735.44

015. Normalization of Fourier series for electron density. B. K. VAĬNSHTEĬN. *Dokl. Akad. Nauk SSSR*, **93**, *No.* 5, 821–3 (1953) *In Russian.*

Using Bunyakovskiĭ's theorem the reflected intensities can be expressed as $1/V\Sigma|F|^2 = \Sigma_i g_i = k\Sigma Z_i^{\alpha}$ where k and α are constants of the type of structure considered, depending on $B(=8\pi^2\overline{u_x^2})$. This can be reduced because g_i, the integral of $\rho_i^2 d\tau$ over the unit cell has an appreciable magnitude only in the immediate neighbourhood of the ith atom. The radial electron densities round atoms are approximated from unitary f curves and corrected for thermal vibrations. Observed structure amplitudes can thus be put on to an absolute basis.
A. L. MACKAY

548.735.44

016. Optical method for determining crystal structures. II. L. BRÚ, M. CUBERO AND V. HERNÁNDEZ MONTIS. *An. Real Soc. Españ. Fis. Quim.*, **49(A)** 77–86 (*March–April*, 1953) *In Spanish.*

For previous part see Abstr. 1875 (1954). The principle of the multiple pinhole camera ("fly's eye") was used in the construction of three different types of gratings—cubic, tetragonal and hexagonal. The "fly's eye" can be easily obtained in every case by means of a transparent glass plate with a series of parallel equidistant straight black lines. Diffraction patterns are in good accordance with the corresponding Fourier projections. An application of the Hanson and Lipson simplified "fly's eye" procedure, and of the Fourier transforms, has been made in an optical survey of the structure of U_6Mn. Finally, two new applications of the "fly's eye" apparatus are given; they have proved very useful in the following problems: building up of a certain projection of the reciprocal lattice, and computation of the electron density in points—different from the atomic centres—belonging to the Fourier projection.
A.

548.736.1

4017. Phase transformation in uranium. B. R. BUTCHER AND A. H. ROWE. Letter in *Nature* [*London*] **172**, 817 (*Oct.* 31, 1953).

X-ray measurements with a microbeam camera on plates of the α-phase which were observed to grow in grains of the β-phase of 1·4 at. %Cr–U alloy, when this was annealed for several hours at 80°C, showed the (001) and (010) α-planes to be parallel respectively to the (817) and (12, 3, 4) β-planes. The {441} plane is suspected as a possible habit plane for the transformation.
A. D. LE CLAIRE

548.736.1

4018. The crystal structure of iodine. A. I. KITAĬGORODSKIĬ, T. L. KHOTSYANOVA AND YU. T. STRUCHKOV. *Zh. fiz. Khim.*, **27**, *No.* 6, 780–1 (1953) *In Russian.*

The crystal structure of iodine has been redetermined with results substantially in agreement with earlier work. Atoms lie in (f) positions in the space group *Ccmb* with (x, z) parameters ($0{\cdot}149_3$, $0{\cdot}115_6$). The 121 observed reflections were corrected for absorption and used to give a Patterson section at $y = 0$. The molecular I–I distance was found to be $2{\cdot}68 \pm 0{\cdot}01$ Å, intralayer distances to be 3·56 and 4·04, and I–I distances between layers 4·35 and 4·38 Å. The form of the molecule is shown in a diagram.
A. L. MACKAY

548.736.1 : 539.154.3

Magnetic moments and crystal structure of ferromagnetic metals and alloys. *See Abstr.* 3771

548.736.3

4019. An X-ray study of the magnesium borides. V. RUSSELL, R. HIRST, F. A. KANDA AND A. J. KING. Letter in *Acta cryst.*, **6**, 870 (*Nov.*, 1953).

Preparation of the borides by heat-treatment of Mg and B under high pressures is described. MgB_2 has a hexagonal unit cell with $a = 3{\cdot}084$ Å, $c = 3{\cdot}522$ Å, obtained from powder photographs, and is isomorphous with AlB_2. Powder patterns of some other borides were also observed.
A. R. STOKES

548.736.4

4020. The reaction of Ta_2O_5 with B_2O_3 and the structure of $TaBO_4$. A. I. ZASLAVSKIĬ AND R. A. ZVINCHUK. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 5, 781–3 (1953) *In Russian.*

$TaBO_4$ crystals were prepared by heating a mixture of 7% Ta_2O_5 in B_2O_3 for 400 hours at 900° and extracted by leaching. The crystals were tetragonal bipyramids of density 7·62 g/cm³. De Jong and Bouman photographs showed the space group to be $I4_1/amd$ and powder photographs gave the dimensions $a = 6{\cdot}201$ and $c = 5{\cdot}475$ kX. Atomic position parameters, found by trial and error are: Ta, (a) positions (0, 0, 0); B, (b) positions (0, 0, ½); 0, (h) positions (0, x, z) with $x = 0{\cdot}17$ and $z = 0{\cdot}32$. The structure is of the $ZrSiO_4$ type.
A. L. MACKAY

548.736.4

4021. Precision determination of the elementary cell parameters of crystals of the monoclinic system. A. F. IEVIN'SH AND YA. K. OZOL. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 3, 527–30 (1953) *In Russian.*

Rotation photographs of monoclinic crystals of

$KClO_3$ and $CaB_2O_4.6H_2O$ were taken with a 64 mm dia. camera enclosed in a thermostat. Photographs were made using Cu, Co, Ni and Fe radiations, θ values of spots with $\theta > 80°$ being measured to 0·01°. Four measurements of θ provided 4 simultaneous equations from which a, b, c and β could be calculated. All possible sets of equations were used and the results averaged. The final error is estimated at about 0·003%. A. L. MACKAY

548.736.4

4022. The crystal structure of ammonium oxide. W. J. SIEMONS AND D. H. TEMPLETON. *Acta cryst.*, **7**, 194–8 (*Feb.*, 1954).

548.737

4023. The crystal structure of iodoform. T. L. KHOTSYANOVA, A. I. KITAĬGORODSKIĬ AND YU. T. STRUCHKOV. *Zh. fiz. Khim.*, **27**, *No.* 5, 647–56 (1953) *In Russian.*

Redetermination—see *Strukturbericht*, **2**, 820. Using an X-ray spectrograph with ionization chamber intensity measurement and also a de Jong and Bouman camera the unit cell dimensions were found to be $a = 6·83$ and $c = 7·53$ Å, each $\pm 0·02$ Å. The space group, using data on the shape of the molecules as well as extinctions is $C6_3$. No correction was made for absorption. An $hk0$ Patterson projection gave the positions of I atoms which led to an $hk0$ Fourier projection locating also the C atoms. The z co-ordinates of the latter were found from a Patterson line at (2/3, 1/3, z) followed by a Fourier synthesis along the same line. The final value of the z parameter of the C atom is 0·096 and the parameters of the I atoms (0·356, 0·044, 0). The accuracy of the determination is discussed. The I–C–I angle was found to be 109° ± 5°, the C–I bonds 2·18 ± 0·06 Å and the intramolecular I–I distances 3·56 Å. A. L. MACKAY

548.737

4024. X-ray structural study of trans-trans-trans-tri-β-chlorvinyldichlorostibine. YU. T. STRUCHKOV AND T. L. KHOTSYANOVA. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 3, 565–8 (1953) *In Russian.*

Crystals were monoclinic, elongated along b, with space group $C2/c$ and $Z = 8$; dimensions were measured as $a = 20·96 \pm 0·1$, $b = 7·00 \pm 0·02$, $c = 17·23 \pm 0·09$ Å and $\beta = 101° 50' \pm 10'$. An F^2-series projection on to the ac-plane gave the x and z co-ordinates of the Sb and Cl atoms. These were refined by two F-series projections. The y co-ordinates of the heavy atoms came from a 3-dimensional F^2 line. For further refinement of Sb and Cl positions and location of C atoms two 3-dimensional F-summations, each using 1202 terms, were calculated. Final positions are tabulated, the errors in C atom positions being estimated at 0·01–0·03 Å. Bond lengths agree with those found for similar compounds. The configuration round the Sb atom is trigonal bipyramidal, with Cl atoms above and below and the three C atoms of the vinyl groups nearly 120° apart in the equatorial plane. The exact shape of each vinyl group is discussed. A. L. MACKAY

548.737

4025. The isomorphism and morphotropy of the molecular crystals $XYAr_3$ (X = S, Se; Y = P, Sb; Ar = C_6H_5, p-$C_6H_4CH_3$). G. S. ZHDANOV, V. A. POSPELOV, M. M. UMANSKIĬ AND V. P. GLUSHKOVA. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 5, 983–5 (1953) *In Russian.*

The unit cells of five compounds of the XYAr type were measured. All had $Z = 4$ and space group $P2_1/n$. Compounds having the same Ar group were isomorphous and all compounds were morphotropic. A. L. MACKAY

548.73

4026. The crystal structure of the addition product $HgCl_2$. coumarine (I) and $HgBr_2$. coumarine (II). YU. T. STRUCHKOV, A. I. KITAĬGORODSKIĬ AND T. L. KHOTSYANOVA. *Dokl. Akad. Nauk SSSR*, **93**, *No.* 4, 675–8 (1953) *In Russian.*

The structures of the compounds I and II were completely determined. I and II were found to be isomorphous, with space group $P2_1/a$ and $Z = 4$. The cell dimensions of I are $a = 23·63 \pm 0·06$, $b = 11·27 \pm 0·03$, $c = 4·03 \pm 0·02$ Å and $\beta = 97°40' \pm 20'$. Patterson and Fourier projections were made on the ab plane and 90% of the signs of general reflections were determined by a statistical method similar to Zachariasen's [Abstracts 4761 (1952)] and 5782 (1953)]. The C and O positions were found to ±0·02 Å and the Cl, Br and Hg positions more accurately. 5 Cl atoms and one O atom surround each Hg atom octahedrally. The planes in which the flat molecules lie are almost parallel to the ab plane. The octahedra surrounding each Hg atom form chains parallel to the c-axis. A. L. MACKAY

548.737

4027. The crystal structure of the normal paraffin hydrocarbons. A. E. SMITH. Letter in *J. chem. Phys.*, **21**, 2229–31 (*Dec.*, 1953).

The space group of the low temperature forms of n-$C_{21}H_{44}$, n-$C_{23}H_{48}$, n-$C_{25}H_{52}$, n-$C_{27}H_{56}$ and n-$C_{29}H_{60}$ is P_{bcm}, not P_{nam} as supposed hitherto. A structure determination of n-$C_{23}H_{48}$ shows that the packing of the molecules is somewhat different but the main structural features are as found on the basis of P_{nam}. The room-temperature forms of n-$C_{20}H_{42}$ and n-$C_{22}H_{46}$ are triclinic, of n-$C_{28}H_{58}$ and n-$C_{30}H_{62}$ are monoclinic, and n-$C_{26}H_{54}$ exhibits both forms. R. S. PEASE

548.737

4028. Unit cell and preliminary structure for cellulose triacetate. W. J. DULMAGE. Letter in *Nature* [*London*] **172**, 1053 (*Dec.* 5, 1953).

Pseudo-orthorhombic, with $a = 24·50$ Å, $b = 11·56$ Å, $c = 10·43$ Å; these data obtained from diffraction photographs of rolled sheets. A possible structure is briefly described. A. R. STOKES

548.737

4029. Crystal structure of benzene at −3°C. E. G. COX AND J. A. S. SMITH. Letter in *Nature* [*London*] **173**, 75 (*Jan.* 9, 1954).

Orthorhombic, $a = 7·46$, $b = 9·67$, $c = 7·03$ Å. The molecule is planar. C — C distance = 1·37$_8$Å: this differs from Stoicheff's value of 1·40 Å from Raman spectrum of vapour at 61°C [Abstr. 7600 (1953)]. A. R. STOKES

548.737

4030. The structure of haemoglobin. II. L. Bragg, J. R. Howells and M. F. Perutz. *Proc. Roy. Soc. A*, **222**, 33–43 (*Feb.* 23, 1954).

For Pt I, see Abstr. 7723 (1952). The outer form of the haemoglobin molecule is delimited by considering the way in which it packs into a number of crystalline forms. A simple spheroidal form of the molecule is found to account for the lattice dimensions with a remarkable degree of consistency. The dimensions of the spheroid are $53\times53\times71$ Å in the case of the hydrated molecule, and $45\times45\times65$ Å in the case of the dry molecule, with an error of less than 2 Å in each direction. The evidence of form birefringence is compatible with these conclusions. They are supported by observed changes in diffraction effects with salt concentration. The spheroidal shape can only be a first approximation, and the protein molecule must be more polyhedral in shape, since in the dry form it occupies a considerably larger proportion of the total volume than would be occupied by spheroids in close packing. The limits to its form which are set by packing contacts are defined. A.

548.737

4031. The hydrogen bond in crystals. IX. The isotope effect in acetylenedicarboxylic acid dihydrate. K. J. Gallagher, A. R. Ubbelohde and I. Woodward. *Proc. Roy. Soc. A*, **222**, 195–206 (*March* 9, 1954).

For Pt VIII, see Abstr. 3539 (1950). Comparisons have been made with oxalic acid dihydrate. Expansion of the crystals occurs on substituting deuterium for hydrogen. The relative magnitude of the effects corresponds with the relative strengths of the acids on the hypothesis that the short isotope bonds involve an overlap of two structures. Brief reference is made to a new thermal transition in the acetylene acid, and to an unexplained split reflection in the deuterium compound. A.

548.74

4032. The structure of thin alkali-halide layers evaporated on to single-crystal bases. H. Lüdemann and H. Raether. Letter in *Acta cryst.*, **6**, 873 (*Nov.*, 1953) *In German.*

Layers of alkali halides were deposited on substrates either of the same compound or of a different alkali halide: these layers were investigated by electron diffraction. A. R. Stokes

548.74

4033. Study on the intensity anomaly of electron diffraction powder patterns from minute silver crystallites. K. Kimoto. *J. Phys. Soc. Japan*, **8**, 762–7 (*Nov.–Dec.*, 1953).

Electron diffraction powder patterns from extremely minute crystallites of evaporated silver show a peculiar intensity anomaly: the most remarkable part of it is that the ratio of the integral intensity of the (200)-reflection to that of the (111)-reflection is far smaller than the one calculated, and the former reflection is much broader than the latter. The anomaly can be ascribed to a stacking disorder in the (111)-plane in the minute silver crystallites. The calculated line profiles can be made to coincide with the observed ones, if the following parameters are adequately determined: α, the probability with which the stacking fault occurs; L_1 and L_2, the dimensions of the crystallites parallel and perpendicular respectively to the (111)-plane of the crystallite; and $\sqrt{\langle u^2\rangle_{AV.}}$, the amount of the average lattice distortion due to small inhomogeneous lattice distortions in the crystallites. For example they turned out to be, for one specimen, $\alpha = 0{\cdot}84$, $L_1 = 20$ Å, $L_2 = 47$ Å; for another specimen, $\alpha = 0{\cdot}70$, $L_1 = 14$ Å, $L_2 = 33$ Å and $\sqrt{\langle u^2\rangle_{AV.}} = 0{\cdot}14$ Å. A.

548.74

4034. Fine structure due to refraction effect in electron diffraction pattern of powder sample. I. Fine structure given by magnesium and cadmium oxide smoke having a fibrous orientation. G. Honjo. *J. Phys. Soc. Japan*, **8**, 776–81 (*Nov.–Dec.*, 1953).

Fine structures due to refraction effect in electron diffraction patterns of cubic magnesium and cadmium oxides are studied when the sample has a fibrous orientation round the [001] axis and the electron incidence is nearly perpendicular to the axis. In the case of magnesium oxide, most of the reflections split into doublets corresponding to the ordinary refraction effect due to a mean inner potential of 15–16 V; (002) reflection, however, splits into a quartet corresponding to the double refraction effect, which was formerly pointed out by Sturkey, the separation of which is also in accordance with the theoretical expectation. The intensities of the two spots corresponding to a double refraction are found to be remarkably different; the spot of larger deviation is weaker than that of smaller deviation. In the case of cadmium oxide, though the fine structures of the fibrous reflection are less apparent than in the case of magnesium oxide, it is noted that the (111) reflection splits only into a doublet showing anomalously small separation, although a well separated quartet corresponding to a large double refraction effect is expected. The doublet, however, is to be considered as the two inner spots of the quartet, while the outer two are undetectable on account of a much exaggerated intensity difference between the doubly refracted electron rays and that of (002) for magnesium oxide. A.

548.74 : 535.249

Microdensitometry of electron diffraction photographs. *See Abstr.* 3257

548.74 : 537.533.73

High angle Kikuchi patterns. *See Abstr.* 3542

548.74 : 539.185

4035. On the diffuse reflexion of neutrons by a single crystal. R. D. Lowde. *Proc. Roy. Soc. A*, **221**, 206–23 (*Jan.* 21, 1954).

The thermal diffuse reflections from a single crystal result from an exchange of energy, as well as momentum, between the beam and the crystal. The theory is outlined for the case of neutron radiation, and some properties of the diffuse reflexions are derived. Diffuse streaks have been found in the Laue diffraction pattern of an iron single crystal placed in an unmonochromatized beam of neutrons from the Harwell pile. The 110 streak has been studied in detail, and its

behaviour is compared with calculations from the Weinstock–Waller–Froman theory of inelastic neutron scattering. The theory is verified to within about 15%. Inelastic scattering cross-sections are given for neutrons incident at 20° on the (110) plane; they are in the region of 10 millibarns. A.

548.74 : 548.5

4036. Crystalline chlorophyll and bacteriochlorophyll. E. E. JACOBS, A. E. VATTER AND A. S. HOLT. Letter in *J. chem. Phys.*, **21**, 2246–7 (*Dec.*, 1953).

When an acetone solution of pure chlorophyll *a* is diluted with distilled water a colloidal suspension is formed, but if Ca^{++} ions are added to the water either before or after dilution, the pigment crystallizes in the form of triangular sheets. An electron-micrograph of such crystalline sheets is reproduced. Crystallization can also be achieved by other procedures without the use of Ca^{++} ions. Bacteriochlorophyll can be crystallized from a concentrated solution in a mixture of 25% ether and 75% petroleum-ether by slowly evaporating the ether. These crystalline preparations have shown no change in absorption spectra after storage, in the dark, at room temp. for several months. X-ray powder diffraction patterns are reproduced. J. IBALL

GEOPHYSICS 55

550.37 : 550.38

4037. Two types of oscillation of the earth's electromagnetic field and their diurnal variation in universal time. V. A. TROITSKAYA. *Dokl. Akad. Nauk SSSR*, **93**, *No.* 2, 261–4 (1953) *In Russian.*

An analysis of Russian observatory records has shown the existence of rapid variations in both the electrostatic and magnetic fields. The first type is a continuous oscillation between about 0 and 12 hr. Universal time with a maximum amplitude at 2–4 hr. and a period of 10 to 40 sec. The second type is a train of pulses with a period of 40–63 sec and occurs mainly between 12 and 24 hr with a maximum at about 18–19 hr. J. M. HOUGH

550.93

4038. Determination of the age of the earth from the isotopic composition of meteoritic lead. F. G. HOUTERMANS. *Nuovo Cimento*, **10**, 1623–33 (*Dec.*, 1953).

Under the assumption that (*a*) the isotopic constitution of lead at the time of the formation of the lithosphere is represented by the figures found for lead from the troilite phase of the Cañon–Diablo meteorite [Abstr. 1589 (1954)], and (*b*) the majority of tertiary lead ores analysed for isotopic constitution has been formed according to the simple model of primary origin, the age of the lithosphere w follows as $w = 4{\cdot}5 \pm 0{\cdot}3 \times 10^9$ yr. A.

551.48.018 : 778.3 : 532.593

A simple optical method for measuring the statistical distribution of water surface slopes. *See Abstr.* 3168

ATMOSPHERE . METEOROLOGY 551.5

551.508.11

4039. A radioactive altimeter for stratosphere balloons. K. KRISTIANSSON. *Ark. Fys.*, **6**, *Paper* 30, 317–19 (1953).

The altimeter consists of an aluminium tube 15 cm long, and open to the atmosphere, with a polonium α-source at one end and a C-2 photographic plate at the other. The range of the α-particles in the emulsion gives a measure of the air density and by counting the number of tracks as a function of range in the emulsion the time spent at different altitudes can be estimated. H. ELLIOT

551.508.71 : 536.532

4040. An investigation of thermocouple psychrometer. I. S. KAWATA AND Y. ŌMORI. *J. Phys. Soc. Japan*, **8**, 768–75 (*Nov.–Dec.*, 1953).

The properties and use of thermocouple psychrometers consisting of fine wires of constantan and manganin have been studied. Various effects on psychrometric measurements have been examined experimentally, such as transference of heat through wires and through air between dry- and wet-junctions, ventilation, and indication lag; the elimination of errors due to them is discussed. The thermocouple psychrometer is of rapid response owing to its small thermal capacity, and its wet-junction is cooled sufficiently by slight ventilation, mostly due to its small size which makes the effect of radiation on the wet-junction small. A.

551.508.99 : 621.396.91 : 621.396.61

4041. Automatic long-range radio transmitters of meteorological recordings over a long period. E. PLÖTZE, K. RAWER AND E. STOEBE. *Z. angew. Phys.*, **5**, *No.* 9, 351–9 (1953) *In German.*

The apparatus automatically records all types of ground and sea level meteorological data in the Atlantic and arctic regions, and transmits them, several times daily over a period of several months, to European land-stations. G. M. BROWN

551.510.535

4042. Correlation between variations of surface pressure and ionospheric parameters. M. R. KUNDU. *Indian J. Phys.*, **27**, 235–43 (*May*, 1953).

Possible existence of correlation is examined by statistical analysis of the meteorological and ionospheric data of Calcutta for the years 1948–1951. It is found that in some months, at least, of a year the changes in the ionization value in course of the month (for a given hour of the day) have strong correlation with the pressure changes at the ground at the same hour in course of the same month. Further, for the same months, the variations of the average day- and night-time ionization densities of

E-region are found to have good correlation with pressure variations in course of the month at a particular hour. These results are in conformity with those obtained by Martyn and Pulley in Australia. Some possible explanations of such correlations that have been suggested, namely, that variations of ozone content as occur in the ozonosphere (causing temperature variation) reach the ionospheric heights, or, that the effects of tropospheric disturbances reach the same heights by leaking through the stratosphere, are examined. It is maintained that before arriving at any definite conclusion regarding the correctness or otherwise of these explanations, it is essential that the types of the association that probably exist are established unambiguously, by long continued observations in different parts of the world. A.

551.510.535

43. Solar tides in the F_2 region from the study of night-time critical frequencies. A. A. Weiss. *J. atmos. terrest. Phys.*, **4**, 175–83 (*Dec.*, 1953).

Night-time critical frequency variations at 25 ionospheric stations are analysed by season and by latitude for semi-diurnal solar tidal terms. The amplitude and phase of the vertical drift velocity of electrons so found are consistent with accepted tidal theory, and an estimate of the height-gradient of the vertical drift is obtained. Two parallel analyses are made, on the alternative assumptions that decay proceeds according to a recombination law or to an attachment law. The low values found for the decay coefficients preclude any decision as to which of these two decay processes is actually operative. A.

551.510.535

044. Semidiurnal currents and electron drifts in the ionosphere. J. A. Fejer. *J. atmos. terrest. Phys.*, **4**, 184–203 (*Dec.*, 1953).

The differential equations of the dynamo theory for the terrestrial ionosphere are solved numerically under simplifying assumptions. The calculated current densities are used to estimate tidal velocities in the ionosphere necessary to produce the quiet day magnetic variations. A tidal amplification of about 10 compared with velocities on the ground is calculated. The calculated velocities and phases of vertical electron drifts are in reasonable agreement with experimental determinations of lunar tidal variations in measured virtual height of the different ionospheric layers. The calculated velocities and phases of horizontal electron drifts fit observations on long duration meteor echoes but the calculated phases are opposed to those obtained from fading measurements. The fading measurements appear therefore to refer to air movements and not to electron drifts. A.

551.510.535

045. The measurement of ionospheric absorption using observations of 18·3 Mc/s cosmic radio noise. A. P. Mitra and C. A. Shain. *J. atmos. terrest. Phys.*, **4**, 204–18 (*Dec.*, 1953).

A new technique permits measurement of the total attenuation suffered by 18·3 Mc/s cosmic radio noise passing completely through the ionosphere. It is shown that the total absorption may be divided into two components, one due to absorption mainly in the *D* region and the other in the F_2 region. The observations of *D* region absorption confirm the diurnal and seasonal variations observed by other workers. F_2 absorption depends on the critical frequency but not on the height of the region and there is evidence of increased absorption at night which may be caused by irregularities in the upper *F* region. The observational results are compared with those obtained by other workers and suggestions are made for the use of the method, particularly in the exploration of the upper F_2 region. A.

551.510.535

4046. The analysis of ionospheric records (ordinary ray). I. D. H. Shinn. *J. atmos. terrest. Phys.*, **4**, 240–54 (*Dec.*, 1953).

Tables are presented from which it is possible to construct the theoretical (h', f) curves for a "parabolic" layer (both for reflection from and for penetration through the layer) and also for a "linear" layer anywhere in the world, except at very high latitudes. The effect of the earth's magnetic field, but not that of electronic collisions, is included. Methods of deducing the electron density in the ionosphere have until now been based on calculations in which the effect of the earth's magnetic field is neglected. Necessary modifications to two of these methods are described. A.

551.510.535 : 537.568

Recombination in the *F*-layers. *See Abstr.* 3621

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 3691–4

551.510.535 : 550.386 : 523.75

4047. Determination of the location of the ionospheric current system responsible for geomagnetic effects of solar flares. A. P. Mitra and R. E. Jones. *J. atmos. terrest. Phys.*, **4**, 141–7 (*Dec.*, 1953).

A new method for locating the ionospheric current system associated with solar flares is presented. The method depends on the time of maximum intensity of a geomagnetic flare effect and the enhancement of electron density at the relevant level. It is found that the flare current system is located either at 100–130 km (if one assumes that the flare effect is essentially one of enhancement of the *Sq*-current) or at 60 km (if it is an independent system). A.

551.510.535 : 621.396.11

4048. Study of propagation characteristics of obliquely incident impulse wave in time of the solar eclipse. K. Miya, T. Murata and H. Wada. *Rep. Ionosphere Res. Japan*, **4**, *No.* 1, 1–20 (1950).

Reception at 3 sites on and around the day of the solar eclipse of May 9, 1948, of the same impulse wave (9·24 Mc/s, duration 0·1 msec.) from a common transmitter was used to give information on waveforms, field intensities, relative time differences and incident angles of downcoming waves. Propagation characteristics for oblique incidence were thus determined and compared with results obtained by vertical sounding. The differences are small for comparatively short distances, but the composition of the downcoming waves becomes complicated and difficult to interpret for the longest propagation distances.

G. M. BROWN

551.510.535 : 621.396.11

4049. The effect of sunrise on the reflection height of low frequency waves. S. B. BROWN AND W. PETRIE. *Canad. J. Phys.*, **32**, 90–8 (*Jan.*, 1954).

It has been found that when radiowaves of frequency 16 kc/s and somewhat higher are transmitted over distances of 540 km, the phase and amplitude of the received signal change suddenly about one hour before ground sunrise at the mid-point of the transmission path. This effect results from a lowering of the night-time reflection height of 95 km to the daytime value of 70 km. By considering the geometry of the situation, it is apparent that the process of photoionization of atmospheric molecules cannot produce the observed effect since the relevant wavelengths are absorbed before reaching the 95 km height. On the other hand, electrons may be removed from negative oxygen ions by visible and near infrared radiation which does reach the 95 km level prior to sunrise. The problem is then to determine the intensities of the relevant wavelengths at the 95 km level, and to compute the rate at which electrons are released from negative ions. It is shown that the pre-sunrise effect at 95 km is readily explained as a negative ion phenomenon, and the rate of fall of reflection height is discussed. A.

551.5

4050. Polarization of radar echoes from meteor logical precipitation. I. M. HUNTER. Letter *Nature* [*London*], **173**, 165–6 (*Jan.* 23, 1954).

Measurements have been made using a specia constructed set for which the ellipticity of the tra mission and reception is accurately known on wavelength of 3·2 cm. The results obtained f reflection from gentle rain are in good agreement wi theoretical expectations but for stronger precipitati there is an appreciable departure from sphericity.

J. M. HOU

551.59

4051. Note on the scattering from mist drople F. RÖSSLER. *Optik*, **10**, *No.* 11, 554–6 (1953) *German.*

Atmospheric transmission measurements by Ko [Abstr. 4552 (1950)] are compared with the Stratt and Houghton calculations for scattering by wa drops. G. F. LOTHI

551.593.9 : 535.338

The Herzberg bands of O_2 in an oxygen aftergl and in the night sky spectrum. *See Abstr.* 3292

BIOLOGY 57/59

577.3 : 536.7

4052. Thermodynamical analysis of life. I. Thermodynamics of transient phenomena. M. SUGITA. *J. Phys. Soc. Japan*, **8**, 697–703 (*Nov.–Dec.*, 1953).

The idea of the quasi-static change is based on the local equilibrium. It is here generalized on the basis of molecular kinetics. The author considers a quasi-chemical reaction of the type $\Sigma\nu_{js}A_j \rightarrow \Sigma\nu_{ks}A_k$, whose rate is $\dot{q}_s$ and for which the distribution function of A_i is n_i. Then $\dot{G} = \sum_i \mu_i \dot{n}_i = -\sum_s (\sum_j \nu_{js}\mu_j - \Sigma\nu_{ks}\mu_k)\dot{q}_s$, where μ_i is the chemical potential of A_i and G is Gibbs's free energy. In the transient state some of the $\dot{q}_s$'s are yet very small and they are called the second co-ordinate. Then $\Sigma\nu_{js}\mu_j - \Sigma\nu_{ks}\mu_k \simeq 0$ on the co-ordinate. This is the generalization of the local equilibrium. Then the product term of G is a small quantity of higher order and may be neglected. Then it may be expressed by a finite number of $\dot{q}_s$'s, which cannot be neglected and are called the first co-ordinate. Such a change of state, which is expressed by a finite parameter, is called generalized quasi-static. In the following the living system is assumed to be in such a state. Here $(\Sigma\nu_{js}\mu_j - \Sigma\nu_{ks}\mu_k)_s\dot{q}$, of the first co-ordinate, is the heat from the virtual heat source, which is the fundamental idea of this paper. Thermodynamics cannot be applied to the first co-ordinate, but an empirical relation between $\dot{q}_s$ and the field of chemical potential can be assumed, which can be introduced thermodynamically. Thermodynamical analysis of the phenomena of life is given in Pts II and III. A.

577.3 : 536.7

4053. Thermodynamical analysis of life. II. On the maximum principle of transient phenomena. M. SUGITA. *J. Phys. Soc. Japan*, **8**, 704–9 (*Nov.–De* 1953).

The principle is called by Rayleigh the principle the least dissipation of energy. The other aspect this principle is the equilibrium of the second c ordinate. It is a very important law of nature a might be called the fourth law of thermodynamic The most important meaning of this principle is se in its application to biophysics. An attempt establish the basis of this principle is made in Pt III

577.3 : 53

4054. Thermodynamical analysis of life. III. Math matical analysis of metabolism. M. SUGITA. *Phys. Soc. Japan*, **8**, 709–13 (*Nov.–Dec.*, 1953).

A living organism is an open system, in whi chemical substances are taken from the extern system and excreted. Let the free energy taken a excreted be Z_1 and Z_2 respectively, then the change the free energy of the organism is $\dot{G}_k = Z_1 - Z_2 -$ where D is the free energy used to maintain life or f external work W. If G_a is the free energy of t external system, then $-G_a = Z_1 - Z_2$ and the secon law may be written in the form $\dot{G}_a + \dot{G}_k = -D <$ On the other hand $\dot{G}_k$ can be written in the for $\dot{G}_k = R - D_r$, where $R = Z_1 - Z_2 - W - D_f$, D_r $D - W - D_f$, and D_f is the energy loss in the bod This is the fundamental equation of thermodynami of life. R is the repair of free energy of the organis and D_r is its depreciation.

578.087

4055. An actograph for small insects. J. HAMMOND. *J. sci. Instrum.*, **31**, 43–4 (*Feb.*, 1954).

An actograph is described which records the mov

nts, in one direction only, of an insect weighing g. Movement of the insect over a length of 9 in. recorded continuously across 35 mm sprocketed n or paper by a camera. The camera has provision moving the film which provides a time base. A.

578.088.5

56. An interesting phenomenon associated with adiation of dry maize seeds. D. SCHWARTZ. *ience*, **119**, 45–6 (*Jan.* 1, 1954).

Samples of dry maize seeds exposed in 7 in. thick hemispheres at varying distances from an atomic plosion (i.e. fast neutron bombardment) were und, after removal and germination, to show unted growth after small dosage, but an increase er very high neutron doses. The process was re- ated under laboratory conditions using Co^{60} radia- n. It is concluded that the "growth" was due to ll elongation in the complete absence of division. is recommended that complex biological effects such growth and survival as an index of dosage received, ould be avoided. D. V. MABBS

578.088.5

57. The production of dominant lethals in *droso- ila* by fast neutrons from cyclotron irradiation and uclear detonations. W. K. BAKER AND E. VON ALLE. *Science*, **119**, 46–9 (*Jan.* 1, 1954).

It is suggested that previous disagreement over the lative biological efficiency of fast neutrons in pro- ucing chromosome aberrations in *drosophila* and *adescantia* has been due to inaccurate neutron osimetry or the use of γ-contaminated sources. ield (atomic explosion) and controlled (86 in. cyclo- on) experiments have here shown that the relative iological efficiency (in producing chromosome berrations) of fast neutrons as compared with X-rays, about as great in *drosophila* as in *tradescantia*.

D. V. MABBS

578.088.5 : 539.169

Radioelements used as tracers in biology. *See bstr.* 3828

578.088.5 : 614.898

058. The relative biological effectiveness of radia- on from a nuclear detonation on *tradescantia* chromo- omes. A. D. CONGER. *Science*, **119**, 36–42 (*Jan.* 1, 954).

The correlation between biological effect (*trades- antia*) chromosome breaks and physical dosage air ionization) is measured for the cases (1) flash xposures to γ-rays of different doses, (2) fast neutrons t high intensities, and (3) mixed radiation in an eroplane passing through an atomic cloud. Control nd field experiments are compared. Results are very ully recorded and analysed. It is concluded that enerally, physical instruments are reliable indicators f likely biological damage. D. V. MABBS

578.088.5 : 614.898

059. The effects of fast neutrons from a nuclear letonation on chromosome breakage in *tradescantia*. . S. KIRBY-SMITH AND C. P. SWANSON, with appendix y C. W. SHEPPARD AND E. B. DARDEN, JR. *Science*, **19**, 42–5 (*Jan.* 1, 1954).

Physical measurement of fast neutrons near an atomic explosion is complicated by the unknown γ-ray contribution. Comparison of laboratory-controlled and field experiments with fast neutrons show, however, that the relative biological effect (*tradescantia* chromosome breaks per rep) in the two cases agrees within $\pm 25\%$. Plots of results are shown. Details of standardization of the physical measurements (using a BF_3 proportional counter, and ethylene-filled polyethylene ion-chambers) and methods of distinguishing γ-rays, slow and fast neutrons, are given. D. V. MABBS

591.181

4060. Ion exchange during the action of neural fibre. A. M. MONNIER. *Cahiers de Phys., No.* 45, 58–84 (*Sept.*, 1953) *In French.*

A well-referenced review and discussion of the recent results of applying the technique of radio-active isotopes to the problem of ion exchange between neural fibres and their environment during their action. F. LACHMAN

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.84 : 535.343–15

The infrared absorption of the crystalline lens. *See Abstr.* 3301

612.843.51

4061. A study in binocular flicker. F. H. PERRIN. *J. Opt. Soc. Amer.*, **44**, 60–9 (*Jan.*, 1954).

If both eyes are subjected to flickering stimuli of equal luminance and frequency, the critical fusion frequency is usually somewhat higher when the stimuli are in the same phase than when they are in the opposite phase. The difference in fusion frequency for the two cases is herein termed the *Sherrington effect* after its discoverer. Apparatus for measuring this effect is described in the present paper. It was found that, for a 2° visual field and dark surround, the Sherrington effect was proportional to the mean critical frequency for the two eyes as the field luminance was varied, being about 8% of it for the present observer. At constant field luminance, the effect approached zero as the field angle approached zero but was approximately constant for angles greater than 2°. The mean monocular fusion frequency for seven observers was below the simultaneous (in-phase) binocular frequency, and for a 0·25° field it was even below the alternate (out-of-phase) frequency; for three observers, it was below the alternate frequency for a 2° field. The present data appear to be inadequate to serve as a basis for deciding between alternative explanations of the phenomena. A.

612.843.611

4062. Effect of different preadapting luminances on the resolution of visual detail during dark adaptation. J. L. BROWN. *J. Opt. Soc. Amer.*, **44**, 48–55 (*Jan.*, 1954).

Luminance thresholds for the resolution of various widths of grating line were determined during dark adaptation following light adaptation to luminances

of 0·98, 100, 1290, and 11 200 millilamberts. The dark adaptation curves for the finest gratings, representing high visual acuity, start at a high initial luminance and drop to a final steady level after 5 to 10 minutes in the dark, as is characteristic of cone function. Curves for coarser gratings may display both cone and rod portions, or after light adaptation to low luminances may represent rod function only. The higher the degree of resolution required, the higher the position of the dark-adaptation curve on the log threshold luminance axis. Increasing the level of light adaptation results in higher initial threshold luminances and a more gradual decline to a final steady value. The final steady value of threshold luminance for a given grating size is little influenced by the level of light adaptation. A.

612.843.611

4063. Rapid changes in foveal sensitivity resulting from direct and indirect adapting stimuli. R. M. Boynton, W. R. Bush and J. M. Enoch. *J. Opt. Soc. Amer.*, **44**, 56–60 (*Jan.*, 1954).

It is well known that an intense stimulus imaged upon one part of the retina has the capacity to reduce the sensitivity of a spatially remote area. Controversy has long existed regarding the interpretation of this effect—whether it is the result of stray light in the eye or of some kind of indirect inhibition. A method first used by Crawford makes it possible to measure sensitivity changes associated with the onset of an adapting stimulus by determining the threshold of a test flash at various times near the onset of the adapting stimulus. Two adapting stimuli were used alternately within each experimental session. The "direct" adapting stimulus was concentric with and larger than the foveal test flash; the "indirect" or glare-adapting stimulus was presented at a glare angle of 18°. When the luminances of these radically different adapting stimuli were suitably adjusted, the resulting foveal sensitivity changes, as a function of time after onset of adapting stimulus, were found to be identical. The equivalence held when the luminance of each adapting stimulus was reduced 1 log unit. The results are interpreted as favouring the stray-light hypothesis. A.

612.843.611

4064. Note on the electrical response of the human eye during dark adaptation. M. Alpern and J. J. Faris. *J. Opt. Soc. Amer.*, **44**, 74–80 (*Jan.*, 1954).

Measurement of the magnitude of the principal component of the electrical response of the human eye to an intense flash of light, as a function of time in the dark following five minutes of light adaptation to an extremely bright field, shows an increasing response as a function of time in the dark. The curve levels off at a plateau before a second abrupt rise at about seven minutes in the dark. This break in the curve resembles the rod-cone break in the psychophysical dark-adaptation curve, in that a decrease in the level of prior light adaptation reduces the prominence of the break or even eliminates it. The variation in the initial dark electrical response after various time intervals of prior light adaptation resembles the variation in cone threshold after various durations of light adaptation. A.

612.843.6

4065. Visual acuity and spectacles. T. Graff. *Optik*, **10**, *No.* 10, 506–12 (1953) *In German.*

When measuring visual acuity, a correction factor is shown to be necessary when spectacles are worn. The method of determining the correction factor is given and sample curves are shown. R. W. Fish

612.8

4066. A cortical test of auditory function in experimentally deafened cats. J. E. Hind and H. F. Schuknecht. *J. Acoust. Soc. Amer.*, **26**, 89–9 (*Jan.*, 1954).

This investigation was designed to study the correlation between behavioural audiograms and recordings of cortical potentials in experimentally deafened cats. Cortical thresholds were defined as the minimum intensity of tone pulses capable of eliciting strychnine potentials. Curves expressing threshold elevation with respect to normal animals were prepared for both the behavioural and cortical responses; these graphs were proportioned in accordance with the anatomical frequency scale and displayed above charts of cochlear histopathology. A mean value of 3·0 db greater loss for the behavioural test was obtained when the differences between corresponding pairs of behavioural and cortical threshold elevations at all frequencies in all animals were averaged algebraically. The standard deviation of this collection of threshold differences was 17·4 db. Hypotheses advanced to explain the discrepancies include the effects of: (1) uncontrolled physiological variance in the cortical recording procedure; (2) the fact that the absolute cortical threshold exceeds the absolute behavioural threshold by 30 to 40 db; (3) the use of an abrupt onset for the cortical tone pulse. It is concluded that the cortical test is the most practical and descriptive electrophysiological indicator of threshold cochlear function presently available although it cannot be considered a precise substitute for behavioural threshold determinations. A

614.898

4067. Radiation monitor protects lab workers. R. H. Delgado. *Electronics*, **26**, 150–3 (*Nov.*, 1953).

A description, with circuit details, of the "hand and foot monitor" for radioisotopes. Halogen-quenched β-ray counters are used and the instrument is fully automatic, timing each exposure and resetting after use. F. T. Farmer

615.837 : 534.321.9

4068. The question of damage in ultrasonic therapy. T. F. Hueter. Letter in *J. Acoust. Soc. Amer.*, **26** 104 (*Jan.*, 1954).

Criteria are suggested for ensuring the proper use of ultrasound in physical therapy and in particular for avoiding damage to patients. A

616–073.75

4069. Localization of brain tumors with positron emitters. G. L. Brownell and W. H. Sweet. *Nucleonics*, **11**, 40–5 (*Nov.*, 1953).

The method described involves the use of two NaI scintillation counters with lead collimators. The axes of the collimators are coincident and their apertures face one another. The position of a positron

splitting point source placed between the counters can be determined with good resolution, both from the single count rates and the rate of coincidences between the two counters, which detect the annihilation quanta emitted by the source. Scattering and absorption of the annihilation radiation in any material surrounding the source do not have any substantial effect on the resolution. L. R. SHEPHERD

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4070. Resolving power of the photographic system at small contrast values. G. A. ISTOMIN. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 5, 1001–4 (1952) *In Russian.*

For previous work see *Dokl. Akad. Nauk SSSR*, **81**, *No.* 2, 273–6 (1952). Presents 3 empirical formulae, one of which was derived by L. P. Moroz (1951), for the evaluation of the resultant resolving power of the photographic system (with and without the system negative-emulsion/positive-emulsion, particularly in the contact-printing process). The graphs included show (1) the graphical method of determining the resultant resolving power (R_r), (2) variation of R_r of the photographic system with the factor of contrast of the test object, and (3) the shape of the R_r curve for different conditions. F. LACHMAN

771.351

4071. On the structure in depth of the image of the photographic objective. V. BLUMOVÁ, J. HRDLIČKA, L. KUČEROVÁ AND K. SLONEK. *Czech. J. Phys.*, **3**, *No.* 2, 86–95 (1952) *In French.*

Diffraction patterns along and perpendicular to the optical axis are shown for the image of a point produced by an ideal lens. Contrast and resolving power decrease on moving along the axis away from the primary diffraction max. The case of an anastigmat ($f = 7{\cdot}5$ cm) is considered for illustration of the effect of spherical aberration. The distribution of light along the axis now becomes unsymmetrical, and varies with the lens aperture. Graphs are given of the resolving power in μ *v.* distance along the axis, for apertures of $f/1{\cdot}8$, $2{\cdot}0$, $2{\cdot}5$ and $2{\cdot}8$. In this series two nearly equal max. of resolution separated by 0·1 mm gradually merge into one wider region as the lens aperture decreases. Microscopic measurements of the spacings of 20 max. and min. were made with results agreeing with calculation. Photographs of images at successive max. and min. up to the fifth max. are reproduced. S. T. HENDERSON

771.53 : 537.533.73

4072. Comment on "The calibration of photographic emulsions for electron diffraction investigations." I. L. KARLE AND J. KARLE. Letter in *J. appl. Phys.*, **24**, 1522–3 (*Dec.*, 1953).

The constancy at low densities of the ratio of exposure to optical density is not an assumption, as stated by Bartell and Brockway [Abstr. 6360 (1953)], but is an experimental fact [Abstr. 8147 (1950)]. It is confirmed by other authors, though Bartell and Brockway's results disagree. S. T. HENDERSON

771.53 : 537.533.73

4073. Reply to comment on "The calibration of photographic emulsions for electron diffraction investigations." L. S. BARTELL AND L. O. BROCKWAY. Letter in *J. appl. Phys.*, **24**, 1523 (*Dec.*, 1953).

The authors agree in principle with Karle and Karle (preceding abstract) except about the range in which deviation from proportionality between exposure and density becomes appreciable. The earlier work quoted by Karle and Karle fits either point of view. S. T. HENDERSON

771.533 : 535.434

Light-scattering effects in unexposed photographic emulsions. *See Abstr.* 3345

771.534

4074. Shape of the iso-opaques of a photographic emulsion. P. V. MEĬKLYAR. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 6, 1255–8 (1952) *In Russian.*

Derives the equation $H/H_0 = 1 + (H_n/H_0 - 1)/(1 + at)^{\frac{1}{2}}$, where H is the actual amount of illumination falling on the emulsion, H_n the amount required to produce a given blackening at short-duration exposures (this magnitude is temperature-dependent), H_0 the amount of illumination at the minimum of the iso-opaque, t time of exposure, and a the relaxation parameter [cf. Abstr. 8739 (1951)]. This equation describes adequately the variation of the iso-opaque for times of exposure below the optimum value. The general equation for the iso-opaque is $H/H_0 = (H_n/H_0 - 1)/(1 + at)^{\frac{1}{2}} + \frac{1}{2}[1 + (1 + 4\gamma e^{-U/kT}/N_0^2)^{\frac{1}{2}}]$, where T is the frequency of thermal vibrations (10^{13} c/s); U—energy of activation of the thermal liberation of the first Ag atom, and N_0—the number of electrons fixed in the centre of the light sensitivity. This equation agrees with experimental data if $U = 0{\cdot}80$ eV. It has been found that N_0 varies inversely as the time of development. F. LACHMAN

771.534

4075. Study of the action of various methods of development on the formation of fog in nuclear emulsions. G. ALVIAL C. *Nuovo Cimento*, **10**, 1616–22 (*Dec.*, 1953) *In Italian.*

771.535

4076. Experiments with thin films of silver sulphide, silver and gold. J. H. BURROW AND J. W. MITCHELL. *Phil. Mag.*, **45**, 208–22 (*Feb.*, 1954).

An account is given of experimental work on the reaction between bromine and (1) thin films of silver sulphide, (2) composite thin films of silver sulphide with silver and gold. It has been established that, under these conditions, silver sulphide reacts with bromine to form silver and a sulphur bromide before silver or gold is attacked. Hickman postulated the existence of this reaction in 1927 to account for the increase in sensitivity which follows the digestion of photographic emulsions with sulphur sensitizers. On the basis of the experimental observations, a new

mechanism is advanced for the formation of the latent image in modern high-speed negative emulsions. A.

778.34

4077. Occurrence of a fission-dust particle in a nuclear emulsion. H. YAGODA. Letter in *Nature [London]* **173,** 79 (*Jan.* 9, 1954).

Microscopic examination of an Ilford G5 plate (photomicrograph shown) after exposure to cosmic radiation in the stratosphere showed a strongly β-active focus of 5–10 μ diameter of estimated activity 10^4 β-decays per sec per g. It is suggested that this is an airborne fission particle which set into the emulsion to a depth of 125 μ during manufacture. Frequency of occurrence of active particles in emulsion is also discussed. D. V. MABBS

778.34

4078. Ionization loss in nuclear emulsions. J. R. FLEMING AND J. J. LORD. Letter in *Phys. Rev.*, **92,** 511 (*Oct.* 15, 1953).

Grain- and blob-density measurements have been made, in G5 emulsions, on the tracks of 31–227 MeV π^--mesons and of μ^--decay electrons. The results are consistent with theoretical predictions. J. J. WILKINS

778.34 : 537.533.74

Measurement of multiple scattering in nuclear emulsions. *See Abstr.* 3548

778.37

4079. Image-converter camera for studies of explosive phenomena. F. C. GIBSON, M. L. BOWSER, C. W. RAMALEY AND F. H. SCOTT. *Rev. sci. Instrum.*, **25,** 173–6 (*Feb.*, 1954).

A single-frame camera is described which uses a pulsed image-convertor tube as a shutter to give 10^{-7} sec exposures. The image-convertor tube converts an optical image into an electron image and reconverts it into an optical image; gating or deflection in the electron phase is easily accomplished. Circuits and methods for application to single-frame photography of high explosive phenomena are given and representative photographs are shown. A.

778.5

4080. High-speed turbine-driven rotating mirrors. W. E. BUCK. *Rev. sci. Instrum.*, **25,** 115–19 (*Feb.*, 1954).

A rotating mirror is the basic element in the highest-speed cameras of both the framing and sweeping image types. The factor of merit of these cameras is determined mainly by the peripheral speed of the mirror. The turbine drive described here will spin th best-quality steel mirror up to its bursting speed. Fla mirrors with faces 17·5 mm wide by 21 mm perpen dicular to the rotational axis are operated regularl at 10 000 r.p.s. A camera designed to use these tu bines and to take pictures at the rate of 3 500 00 frames per sec, with an exposure time of 0·1 μsec, i illustrated. A

778.

4081. Reproduction of colors in outdoor scenes. D. L. MACADAM. *Proc. Inst. Radio Engrs*, 42 166–74 (*Jan.*, 1954).

Available spectrophotometric and colorimetric dat on the colours of skin, hair, grass, foliage, sky an earth are summarized. Typical reproductions of suc colours in Kodachrome and some professional 35 mm motion-picture release prints have been measured an are shown. The results of some judgments for colou quality are compared on the basis of these measure ments. The results are also compared with previou measurements made on colour reproductions in re flection prints. In the case of the reproduction o human skin, the preference seems to be for exac colour reproduction in transparencies, although th fact, previously reported, that this is not so in the cas of reflection prints, is confirmed by new data. Th tolerance for colour reproduction is much greate for transparencies than for reflection prints. A

778.

4082. Subtractive color photography: the role o masks. W. T. HANSON, JR AND W. L. BREWER. *J. Opt. Soc. Amer.*, **44,** 129–34 (*Feb.*, 1954).

Colour photographic masks can be applied in such a manner as to minimize colour-reproduction error in a photographic process, regardless of the source o these errors. Overlapping absorptions of the dyes probably cause the most serious errors and therefore receive the most attention. It is shown, however, tha the lack of negative portions in the required sensitivity distributions contributes appreciably to the repro duction errors and can, at least partially, be corrected for by masking. One set of masking equations is derived which is designed to correct only for the overlapping absorptions of the dyes. A second set is derived which is designed to correct only for the lack of negative portions in the sensitivity distributions. It is shown that the set of equations obtained by combining these two sets of equations is essentially the same as that derived directly to correct for these two sources of reproduction errors considered simultaneously. A.